Interaction Design for Live Performance

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Abstract

The role of interactive technology in live performance has increased substantially in recent years. Practices and experiences of existing forms of live performance have been transformed and new genres of technology-mediated live performance have emerged in response to novel technological opportunities. Consequently, designing for live performance is set to become an increasingly important concern for interaction design researchers and practitioners. However, designing interactive technology for live performance is a challenging activity, as the experiences of both performers and their audiences are shaped and influenced by a number of delicate and interconnected issues, which relate to different forms and individual practices of live performance in varied and often conflicting ways.

The research presented in this thesis explores how interaction designers might be better supported in engaging with this intricate and multifaceted design space. This is achieved using a practice-led methodology, which involves the researcher's participation in both the investigation of, and design response to, issues of live performance as they are embodied in the lived and felt experiences of individual live performers' practices during three interaction design case studies.

This research contributes to the field of interaction design for live performance in three core areas. Understandings of the relationships between key issues of live performance and individual performers' lived and felt experiences are developed, approaches to support interaction designers in engaging individual live performers' lived and felt experiences in design are proposed and innovative interfaces and interaction techniques for live performance are designed. It is anticipated that these research outcomes will prove directly applicable or inspiring to the practices of interaction designers wishing to address live performance and will contribute to the ongoing academic discourse around the experience of, and design for, live performance.

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Publications Arising from this Thesis

The following publications are based wholly or in part on the research presented in this thesis:

Hook, J., McCarthy, J., Wright, P. and Olivier, P., 2013. Waves: Exploring Idiographic Design for Live Performance. In: *Proceedings of CHI 2013.* ACM Press, pp. 2969-2978.

Hook, J., Schofield, G., Taylor, R., Bartindale, T., McCarthy, J. and Wright, P., 2012. Exploring HCI's Relationship with Liveness. In: *Extended Abstracts of CHI 2012*. ACM Press, pp. 2771-2774.

Hook, J., Green, D., McCarthy, J., Taylor, S., Wright, P. and Olivier, P., 2011. A VJ Centered Exploration of Expressive Interaction. In: *Proceedings of CHI 2011*. ACM Press, pp. 1265-1274.

Hook, J. and Olivier, P., 2010. Waves: multi-touch VJ interface. In: *Proceedings of ITS 2010*. ACM Press, p. 305.

Schöning, J., Hook, J., Bartindale, T., Schmidt, D., Oliver, P., Echtler, F., Motamedi, N., and Brandl, P. and von Zadow, U., 2010. Building interactive multi-touch surfaces. In: *C. Muller-Tomfelde, ed., Tabletops - Horizontal Interactive Displays.* Springer-Verlag, pp. 27-49.

Hook, J., Green, D. and Olivier, P., 2009. A Short Film about VJs: Using Documentary Film to Engage Performers in Design. In: *Extended Abstracts of CHI 2009*. ACM Press, pp. 3491-3492.

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CHAPTER 1

Introduction

1.1 Introduction

The principal concern of this thesis is the design of interactive technology for live performance. If a performance is defined as "a public situation in which an audience attends to the actions of one or more performers" (Gracyk, 1997), then a live performance can be defined as a performance that is "heard or seen as the event takes place and not from a recording" (Chambers, 2007).

Live performance is an ever-important activity in our society and culture. Live performances such as music, theatre, stand-up comedy and dance continue to attract large audiences, while notions of liveness, performativity and interactivity have become common values of contemporary arts practices. Moreover, with the erosion of the traditional revenue streams of performers, due to the advent of easily and infinitely replicable digital media, live performance is expected to become an increasingly prevalent form of expression as artists seek alternative sources of income. For instance, in 2007 sales of music concert tickets in the US rose by 8% to a record $3.9 billion (Hau, 2008), while sales of both physical and digital albums fell by 500.5 million units (Goodman, 2008).

Meanwhile, interactive technology has become a progressively significant aspect of both artists and audiences' experiences of live performance. The advent of digital technology has transformed the way we experience live shows. For example, large screens at the side of concert stages afford audiences a superior view of performers than their unmediated vision might otherwise deliver (Auslander, 2008, p. 25), while digital projection has allowed audiences to attend live performances by absent or even deceased artists, such as Tupac Shakur (Rennie, 2012). Furthermore, new practices such as laptop music performance

(Schloss, 2003), VJing (video or visual jockey) (Spinrad, 2005; Faulkner, 2006) and digital live art (Sheridan, Bryan-Kinns and Bayliss, 2007) have arisen in response to the emergence of novel technical possibilities.

As existing forms of live performance evolve and new ones are founded in response to emergent technology, interaction designers are expected to become increasingly involved in the creation of interactive technologies for the domain. However, live performance stands out as a particularly challenging space for interaction design, as the relationship between interactive technology and live performance is affected by a plethora of delicate qualities that have a strong bearing upon the experiences of artists and audiences alike. For example, an audience's experience of a live musical performance is not only affected by the sounds produced by the musicians' interactions with their instruments. Rather, a complex set of interrelationships between artists, audience members, instruments and the environment lead to the senses of community, presence, tension, uniqueness and admiration felt during the show.

The third wave of HCI (human-computer interaction) characterised by Bødker (2006) has brought a new perspective to interaction design, which seeks to support the design of interactive technology as it "spreads from the workplace to our homes and everyday lives and culture". Consequently, the discourse around interaction design, once focused upon the usability and efficiency of workplace PCs, has shifted to consider, for example, notions of experience (McCarthy and Wright, 2004; Hassenzahl, 2010), aesthetics (Heller, 2005) and personal emotional significance (Wallace, 2007). The ideas, theories and methods developed in third wave HCI research stand out as having the potential to form the basis of approaches to interaction design that are sensitive to the complex and subtle design space of live performance. However, live performance presents its own distinctive challenges to interaction designers, which are rooted in the difficulty of engaging live performers' personal and tacit knowledge of (Polanyi, 1958; Polanyi, 1966), and creative views about, their practices in design.

In the research presented in this thesis, the changing landscape of live performance is explored from an interaction design perspective. A practice-led methodology is followed, which involves my own active participation in the design of interactive systems for a number of live performers' practices. By exploring and

designing in response to actual live performers' practices, understandings of the relationship between interaction design and live performance, interaction design approaches for live performance and finally interfaces and interaction techniques for live performance are all developed. These research outcomes are expected to be valuable to both interaction design researchers and practitioners, who wish to design and develop interactive technology for the constantly evolving domain of live performance.

1.2 Research Questions

The research presented in this thesis explores live performance from an interaction design perspective, with the overarching goal of better supporting interaction designers in developing novel and innovative interactive technologies for live performance. The research is guided by these three questions:

- **What is the relationship between live performance and the design of interactive technology?**

It is widely accepted, by both interaction design researchers and practitioners alike, that for the design of interactive technology to be successful it must be grounded upon an understanding of the practices (e.g. motivations, problems and experiences) of the people that a design is intended to serve. In recent years, a growing body of research has emerged that seeks to develop and articulate understandings of the practices of live performers, which interaction designers can gain inspiration and guidance from when designing for the domain. These studies have provided in-depth and compelling insight into the experiences of the artists, audiences, participants and environments of live performance (e.g. Reeves, Benford, O'Malley and Fraser, 2005; Gates, Subramanian and Gutwin, 2006; Sheridan, Bryan-Kinns and Bayliss, 2007; Benford and Giannachi, 2011; Taylor, et al., 2011).

The research presented in this thesis aims to extend and build upon this existing research by developing further understandings of the relationship between interaction design and live performance. The research is focussed primarily on understanding the particular qualities of interactive technology desired by live performers and the impact that those qualities have on both the act

of performing and the longitudinal development of a performer's practice. Consequently, the research aims to identify, in the context of particular genres and practices, how particular qualities of interactive technologies and interaction techniques affect all aspects of live performance, ranging from the artistic aspirations of a performer's artistic practice through to the momentary experience of manipulating a interface during, for example, an improvisational performance.

By exploring the relationship between live performance and the design of interactive technology in this way, it is intended that the research will provide further concrete insight that interaction designers can draw upon for inspiration and guidance when designing interactive technology for live performance. Additionally, it is intended that the outcomes of this aspect of the research will contribute an interaction design focussed perspective to the wider discourse around the relationship between live performance and digital media (e.g. Auslander, 2008). Furthermore, as it is hypothesised that strong parallels will exist between the practices of live performers and other creative users of technology, it is expected that the understandings of the relationship between live performance and the design of interactive technology developed throughout this thesis will also offer valuable insight to those designing interfaces for the wider creative use of computers.

- **What approaches should interaction designers follow when designing interactive technology for live performance?**

Developing understandings of people's practices and experiences of live performance and designing interactive technology in response to them is not a trivial task. Rather, as Schön (1991, p. 79) argues, design is a challenging reflective process that involves a skilfully conducted dialogue between designer and situation. Historically, HCI research has contributed to interaction design practice through the proposal of strategies and approaches that can assist interaction designers in conducting effective design. For example, Cultural Probes, a method that seeks to support the interaction designer in opening up a dialogue with users, has been adopted successfully across a wide spectrum of interaction design practices (Gaver, Dunne and Pacenti, 1999).

In this thesis, it is argued that the domain of live performance presents a range of distinct challenges to the interaction designer. Artists' and audiences' experiences of live performances are defined by plethora of subtle, multifaceted and potentially tacit (Polanyi, 1958) issues that range from the co-presence felt between performers and spectators (Gracyk, 1997) to the spontaneity (Barker, 2003) and ephemerality (Phelan, 1993) of a live show. Furthermore, performers' use of technology in live performance is found to extend beyond tool use, with interfaces playing a crucial role in supporting and developing the creative and expressive goals of individual live performances and artists' longitudinal practices (see Chapter 4). If interaction designers are to successfully design interfaces for live performance, it is anticipated that approaches will be required that equip them to engage with, understand and sensitively respond to these kinds of delicate and complex issues.

The second research question addressed in this thesis explores the development of approaches that can be applied by interaction designers to assist in the understanding of live performers' practices and the proposal of concrete designs in response to them. In order to explore this question, the particular challenges facing interaction designers wishing to design for live performance are identified and understood. Following this, existing approaches are reconfigured, and novel approaches developed, to support interaction designers addressing the challenging activity of designing for live performance. It is intended that the approaches developed will either be immediately applicable by interaction designers, or will have qualities that inspire future methods that respond to the challenging design space posed by the domain. Furthermore, it is hypothesised that the approaches developed might also prove to be useful to interaction designers addressing other domains that are defined by similarly complex, subtle and potentially tacit issues as live performance.

- **How can novel interactive technology be applied appropriately in the design of innovative interaction techniques and interfaces that respond to the practices of live performers?**

HCI research is full of examples of the creative design of innovative interfaces and forms of interaction that respond to real users' practices and

problems, which have proven useful and impactful to interaction design practitioners. From the ubiquitous mouse (English, Engelbart and Berman, 1967) to the offset cursor visualisations used on modern touch-enabled mobile devices such as the Apple iPhone (Vogel and Baudisch, 2007), designs proposed through HCI research have been shown to solve real people's problems and enrich their everyday experiences of technology. Similarly, the research presented in this thesis seeks to contribute novel and innovative interactive technologies and interaction techniques to the domain of live performance.

This final research question is addressed by combining the understandings and approaches developed throughout the thesis, in the course of designing interactive technologies that respond to the creative aspirations of, and solve challenges faced in, the practices of two individual live performers (a VJ and an improvisational electronic musician). As a result, interfaces and interaction techniques are developed that respond to issues ranging from the audience's understanding and experience of a performer's interaction with technology, to a range of qualities of the artist-instrument relationship in improvised electronic music. The designs and interaction techniques resulting from this final strand of the research are expected to have a significant impact upon the practices of live performers, who might utilise them in the future tools and instruments of their practices. Moreover, it is anticipated that the interfaces and interaction techniques proposed will offer inspiration and guidance to interaction designers wishing to develop novel interactive systems, in response to issues similar to those tackled by the designs presented.

It has been argued that designed artefacts can "act as vehicles through which HCI researchers' ideas materialize and take concrete form" (Fallman, 2007) and that designs can act as "an appropriate conduit for the transfer of HCI research to the practice community" (Zimmerman, Forlizzi and Evenson, 2007). Therefore, it is expected that by reifying and illustrating notions of live performance developed throughout the empirical strands of this thesis, the designs developed will afford a complementary means to communicate ideas and findings, which might be more accessible, or of greater interest, to both live performers and interaction design practitioners.

1.3 Research Approach

The research presented in this thesis follows a practice-led approach. That is to say, the research questions are explored through my own active participation in the practice of interaction design for live performance. Live performance is a domain defined by complex and subtle issues, which affect both artists and audiences' lived and felt experiences of performances (see Chapters 2, 3 and 4). An investigation of interaction design for live performance conducted from a detached, external standpoint (e.g. a lab-based study) might not have been sensitive to these subtle qualities of experience, which may exist as phenomena embodied in the situations and lived experiences of live performance. The practice-led approach followed seeks to respond to this challenge by situating the research within a prolonged and detailed engagement with the lived and felt experiences of actual live performers' practices and, in particular, my own in-depth involvement in the challenging, dialogical practice of designing interactive technology for live performance.

The research is structured around three interaction design case studies, which each involve design-led engagement with the practices of live performers. The first case study seeks to develop an understanding of VJs' practices, upon which interaction design for live performance might be grounded. The second and third case studies build upon understandings of live performance developed through the idiographic design of two interactive technologies for live performance: Waves (Figure 1 – left), an interactive surface for VJing and Physics Synth (Figure 1 – right), a physics-based synthesiser for experimental electronic music performance.

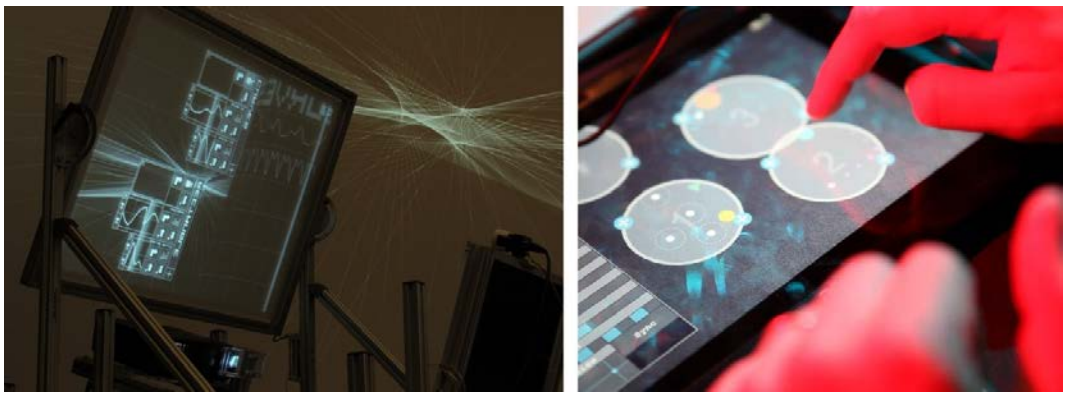

Figure 1: Interactive technologies designed. Waves (left) and Physics Synth (right)

The three practice-led interaction design case studies presented scaffold the exploration of the research questions defined in the previous section. That is to say, each of the questions is not answered separately, through isolated research activities or objectives. Rather, the development of understandings, interaction design approaches and interactive systems for live performance results from my personal response as an interaction designer to the questions and challenges faced when designing in response to the lived and felt experiences of live performers' practices. In this way, the role of interaction design in this research extends beyond a means to produce an artefact. Moreover, designing acts as the basis of an applied inquiry that leads to research outcomes that extend beyond the form, function and experience of the two interactive technologies designed.

1.4 Thesis Outline

The research presented in this thesis, is structured as follows. Chapter 2 explores previous discussion of live performance in fields including theatre, art, music, media studies and interaction design. A number of issues are identified and discussed to form the basis of an initial understanding of live performance, which underpins the empirical, methodological and design-led aspects of the research presented in the remainder of the thesis. The kinds of issues uncovered by the review demonstrate the importance of interaction design approaches that are sensitive to the subtle and complex qualities that affect the experience of interactive technology in live performance. Moreover, the idiosyncratic and often conflicting nature of the dimensions of live performance uncovered by the review suggests that design for live performance should take a more phenomenological approach, which attempts to address lived and felt experiences of live performance directly, rather than through their abstract rationalisation.

In Chapter 3, a number of existing strategies for the design of interactive technology for live performance are reviewed. These strategies are evaluated primarily in terms of the extent to which they support an interaction designer's engagement with subtle issues affecting the experience of interactive technology in live performance. A number of advantageous qualities of interaction design strategies for live performance are identified, which guide those developed and applied throughout the remainder of the thesis. Most crucially, the tacit and

personal (Polanyi, 1958; Polanyi, 1966) nature of live performers' knowledge of their practices is shown to be a key challenge that interaction design strategies for live performance should address.

In Chapter 4, an approach to support the understanding of live performers' practices in the early stages of the design process is developed and applied to a group of VJs. This approach seeks to support interaction designers in conducting the kind of holistic engagement with artists' experiences of live performance called for in the previous chapter. A particular focus is placed upon the surfacing of live performers' tacit knowledge as design insight, which is achieved by using documentary film as a reflective tool. Understandings of the relationship between VJ practice and interactive technology developed during the application of the approach are described. These findings provide valuable design insight, which is applied as a starting point for the design processes described in the following chapters.

Chapter 5 describes the design of Waves, a multi-touch interactive surface for VJ practice. The Waves design is centred on the use of multi-touch gestures to manipulate spline curves, which in turn control the parameters of computer-generated imagery (CGI). This form of interaction is found to offer the VJ expressive and powerful control during the moment of live performance, while also providing a salient and enchanting visual spectacle for audience members. The design of Waves follows an idiographic design approach, which draws insight from the lived experience of an individual live performer's practice. This approach of designing for the individual is shown to allow a concrete design response to abstract issues of live performance to be proposed in a manner that is sensitive to the lived experiences of a particular artist's practice and, moreover, to allow a live performer's creativity to be engaged as design insight. Reflection upon the design approach applied uncovers a number of empirical and methodological findings, including a number of valuable consequences of the live performer's participation in the design process.

Chapter 6 describes the design of Physics Synth, a physics-based synthesiser for experimental live electronic music performance. Physics Synth employs a physics simulation to allow an improvisational electronic musician to generate, manipulate and, most importantly, understand and enter into a

meaningful dialogue with complex and volatile patterns of control data for a synthesiser. Furthermore, the Physics Synth leverages the complex yet predictable behaviour of simulated physical objects to imbue the interface with a sense of having a *life of its own*. In response to reflections on the value of participation uncovered in the previous chapter, when designing Physics Synth the idiographic approach is reconfigured to increase the live performer's participation in the design process. Reflection on the design of Physics Synth uncovers a number of advantageous consequences of increasing the performer's participation in the idiographic approach. Finally, an evaluation of Physics Synth with a number of musicians highlights the potential generalisability of designs that result from an idiographic design strategy.

Chapter 7 draws conclusions from the research presented throughout the thesis. The initial research questions that guided the work are revisited to identify the key contributions made and a number of directions for future research into interaction design for live performance are suggested.

CHAPTER 2

Live Performance

2.1 Introduction

Live performance is an essential activity of many art forms. Consequently, the topic has received considerable attention in the literature of fields including theatre studies, art, music, media studies and interaction design. In this chapter, previous discussion of live performance in these areas is surveyed, with the aim of developing an initial understanding of the issues and experiences that will affect those designing interfaces for the domain.

A number of key dimensions (i.e. issues and qualities definitive of the practices and experiences) of live performance are identified. These dimensions highlight the subtle, complex and in some places conflicting nature of the issues affecting audiences' and performers' experiences of live performances. Furthermore, by contrasting previous theoretical discussion of live performance with selected empirical accounts of technology-mediated live performance, the dimensions illustrate how traditional understandings of issues affecting live performance are complicated by the use of digital technology.

The dimensions presented will be of central concern to interaction designers who wish to develop interactive technologies that engage with both the actions and experiences of live performers and their audiences. Furthermore, it is argued that the subtle and multifaceted nature of the issues uncovered by the review motivates an idiographic approach to the understanding of, and subsequent design for, live performance, which will allow designers to consider how the dimensions uncovered are embodied in the lived and felt experience of different genres of live performance and individual live performers' practices.

2.2 Transience

A conventionally recognised quality of live performance is the unique, one-off, momentary nature of a performance's occurrence. For example, in a discussion of improvisational musical performance, Alperson (1984) defined live performance as a "transitory" phenomenon. Alperson observed that while the creations of a non-performing artist, e.g. sculptures and paintings, are permanent and therefore "can persist and remain relatively unchanged for successive viewings", the work of the performing artist requires "the constant intervention of human agency" to be perceptible by an audience. In other words, live performance is said to be set apart from all other art forms as the speech of the actor, the movements of the dancer, or the sounds of the musician, are fleeting and therefore lost as their initial moment of existence in performance passes.

Phelan (1993, p. 146) argued that despite the existence of recordings, live performances themselves remain inherently ephemeral experiences, existing only in the present, lost forever and consigned to memory, upon their inevitable disappearance. While a recording might allow a performance to be viewed for a second time, it will only act as a "spur to memory" of the original unique event rather than recreate or repeat its experience. In this way, performance is said to be ontologically separate from recorded media as it "cannot be saved, recorded, documented, or otherwise participate in the circulation of representations of representations: once it does so it becomes something other than performance". This separation imbues performance with its "greatest strength" in Phelan's view; an "independence from mass reproduction", which, in contrast to the normative experience of our media-dominated society, "honours the idea that a limited number of people in a specific time/space frame can have an experience of value which leaves no visible trace afterwards" (Ibid., p. 149).

The use of digital technology in traditional live performance settings has resulted in the blurring of distinctions between live and recorded performance. Consequently, transience has become a central concern for those developing digital performances. For example, simulcasts have allowed audiences in venues such as cinemas to view broadcasts of live performances, which occur concurrently but in a different geographical location. In such situations, the audience consumes

the performance as they would a recording and, therefore, careful staging of the performance is required to reinforce the audience's knowledge of, and belief in, the temporal simultaneity and, therefore, the transience of the distant performance (Morris, 2012). For example, Morris described one such performance where a "sense of now was conveyed in part by the images of the gathering Met audience, screened as the cinema audience gathered, but also an on-screen countdown clock showing the time remaining to the start of the performance".

Day of the Figurines (Flintham, Giannachi, Benford and Adams, 2007) was a performance that allowed an audience to participate in a narrative told over a period of 24 days in an imaginary town. The audience experienced this narrative by sending and receiving text messages on mobile devices, which controlled the movements and interactions of a character within the town. This means of interaction with the performance allowed individuals to experience an unfolding narrative asynchronously and over an extended period of time. Consequently, a form of live performance was established that moved away from traditional continuous and simultaneous interaction between co-present performers and audience members and instead allowed audience members to episodically experience a performance as they went about their daily lives (Benford and Giannachi, 2008). However, due to the transient nature of the performance's state, it was found that as audience members interacted intermittently and asynchronously in the town, important events in the narrative could be missed (Benford and Giannachi, 2011, p. 93). Consequently, the creators of the performance were required to carefully craft audience members' interactions with the performance in order to support them in engaging with and experiencing the ongoing, yet momentarily transient, narrative (Ibid., p. 94).

Morris's reflection on the simulcast of opera and Day of the Figurines highlight how traditional notions of transience in live performance are transformed and complicated by digital technology. The use of recorded media in performance can be seen to have the potential to erode the sense of ephemerality traditionally experienced by spectators at live performances, while the inherent transience of action within a live performance can raise design challenges for those wishing to utilise novel technology as the foundation of new forms of temporality in live performance. Consequently, it is argued that as live performance becomes

increasingly mediated by technology, designers will be required to consider, more actively, how interfaces can be designed to both support and enhance, or simply relate to, the sense of ephemerality that has traditionally been fundamental to the experience of live performance.

2.3 Variation

Another commonly heralded quality of the live performance experience, and key constituent of its potential transience, is the existence of variations between different recitals of the same piece of work. Wechsler (2006), for example, noted the existence of “singular moments which vary from performance to performance” of a musical composition. Variation between live performances has been attributed to a number of differing factors, from intentional dissimilarity put in place by those staging improvised cabaret (Cowan, 2010) to more subtle qualities such as liabilities introduced by the humanity of the theatrical performer; for instance, "stage fright, lapses of memory, a stomach ache on stage, a coughing fit, unscripted laughter" (Blau, 2002).

While some accounts acclaim variation to be a definitive quality of live performance, others’ experiences question the extent to which the differences between instances of a performance actually affect the experiences of artists and audiences. Barker (2003) argued that, in the case of theatre, while no two live performances can be identical, most commonly the goal of performers is to resist variation; instead, aspiring to “reach a plateau where everything works to plan, where movements are choreographed, timed and effective, where dialogue is delivered with all the appropriate patina of emotion, character and so on”. Furthermore, referring to the highly produced performances of major pop acts, Auslander (2008, p. 66) highlighted the existence of performances that are repeated on multiple occasions with what would seem to be a primary goal of an exactly replicated audience experience.

Barker’s (2003) analysis of variation in live performance also questioned the frequency with which audiences attend performances of a piece of work on multiple occasions and posited that in the unlikely event that they do, attendance is likely to be motivated by the hope “for as close as they can get to a repeat-experience” rather than variation. This account suggest that variation, while a

prevailing quality of many live performances, might, in some situations, be at odds with the actual experiences certain performers wish to convey and audiences wish to consume.

While Barker (Ibid.) argued that actual significant variations between recitals of theatre performances are rare, he conceded that the notion of variation between performances is an essential quality of the live experience. However, he argued that audiences attend the theatre "as if" there exist elements of uniqueness brought about by variation and, therefore, variation between performances is often experienced not as a reality, but rather as an imagined quality. Therefore, to Barker, in such cases the live experience is differentiated from recorded forms of performance, such as cinema, in terms of the audience's perception of and appetite for variation, rather than its actuality.

A similar viewpoint was privileged in Dixon's (2007, pp. 130-131) phenomenological reading of live performance. Dixon observed that while recorded media is "contained within its own frame" and therefore unable to deviate in any way from its prescribed form, live performance, can unexpectedly leap from its frame at any moment and as such "confront" the audience in ways a recording cannot. To Dixon, it was not important that such occurrences of variation between performances are in fact rare. Instead, he argued that it is the potential rather than actual occurrence of unexpected variations, which creates a "different tension and vulnerability in live performance, a sense of danger and unpredictability that affects the adrenalin and nerves of both the performers and the spectators".

Similarly, Guay (2010) argued that the potential for unexpected variation "ensures the danger" in live theatre performances and as such is an important quality in reinforcing their reality, due to the mimicry of the spontaneity we experience in everyday life. Concerning the latter of these consequences of variation between live performances, parallels can be drawn with Couldry's (2010) discussion of the liveness of televised broadcasts. To Couldry, a sense of liveness is rooted in the extent to which audience members feel connected to the reality of an event. Couldry attributed such realism to the potential for unplanned happenings to interrupt a broadcast at "any time and make an immediate connection to real events".

Whether perceived or actual, it is undeniable that there is some relationship between the subtle variation between performances and audiences' experiences of many forms of live performance. Therefore, it is hypothesised that the notion of variation will be of central concern to interaction designers addressing live performance. Furthermore, the divergent roles played by variation in the accounts of performance discussed, suggest that designers seeking to do so may have to look beyond the kind of abstract discussion presented here and, instead, explore the role that differences between performances play in particular genres or practices. For example, it is expected that the ideas and understandings underpinning a design response to the staged variation in cabaret described by Cowan (2010) would necessarily differ from those employed by a designer considering the polished theatre performances described by Barker (2003).

The increased presence of technology and recorded media in live performance has the potential to further complicate any understanding of variation in live performance, upon which design might be based. Unlike the irreproducible actions and words of an actor or musician's manipulations of an analogue musical instrument, digital technology naturally lends itself to precise and exact duplication. Therefore, as technology is used increasingly in some genres of performance, the prevalence of variation between performances might be exchanged for the exact reproducibility desired by the theatre performers and producers spoken of by Barker (2003). Moreover, audiences may no longer appreciate the value of variation in performance, as they may assume its constituent qualities (e.g. the chance of an unexpected happening or error) will have been resolved by technology. Consequently, it is argued that variation between instances of live performance might become a particularly pertinent issue as recorded media is increasingly utilised in live practices, such as VJing or sample-based electronic music performance.

The increased use of digital technology in live performance has also lead to new forms of variation between performances of the same work. For example, Avatar Farm was a drama performance by a number of actors and players who each used a desktop PC to control a character in a 3D virtual environment (Craven, et al., 2001). During this performance the actions of actors were recorded. This recording was then subsequently presented to audiences using a number of

different interfaces. These interfaces included an online performance where audience members could move amongst the actors and a tabletop interface that allowed audience members to view and interact with a top down map showing the actors' positions within the performance environment (Greenhalgh, Flintham, Purbrick and Benford, 2002). Unlike a video recording of a live performance, these means of presenting the original Avatar Farm performance allowed audience members to control how the original performance was presented to them and explore the performance environment. Consequently, Avatar Farm demonstrates how digital technology can be used to introduce a new form of variation between live performances, where different forms of display and interface technologies are combined with the creativity and curiosity of audience members to develop unique performance experiences from an unchanged recording of an original show (Benford and Giannachi, 2011).

2.4 Improvisation

Improvisation is one significant source of spontaneous variation between live performances that has not been addressed in this discussion so far. Alperson (1984) defined improvisation, in musical performance, as a "spontaneous kind of music-making" and theorised that the act of improvising "bridges the distinction between composition and performance". Alperson based this argument upon Margolis's type/token distinction; a classification whereby artworks, e.g. paintings, are seen as tokens that instantiate an abstract type, such as a particular artistic genre or style (Margolis, 1980). Non-improvised performances were said to be tokens, which instantiate compositions, the abstract type. Improvisation, however, was separated as a different form of performance as both the composition and its performance (the type and token) are created simultaneously.

Alperson's discussion raises an important point; that the act of improvisation differentiates an improvised performance from a non-improvised one, by placing the artist's creativity, which might have otherwise occurred previously in a setting such as a studio, centre stage during the moment of performance. Sawyer (2009) reiterates this position when discussing creativity in improvised jazz, stating, "Unlike compositional creativity, which involves a long

period of creative work leading up to the creative product, in improvisational performance, the creative process and the resulting product are co-occurring".

This coalescing of the performer's creative process and the presentation of its result to the audience may have a particularly strong bearing on the audience's experience of many improvised performances. It has been said that non-improvised performances, like non-performance art forms, are appreciated primarily in terms of their product rather than the creative process that led to that product (Sawyer, 2000). For example, someone attending a gallery experiences the painted canvas rather than the act of painting. However, improvisation has been said to place an "emphasis on creative process" and, therefore, introduce creativity as a primary element of the audience's experience, where it was once absent (Ibid.). Alperson (1984) argued that, as a result, improvised live performances are experienced "as if the improviser's audience gains privileged access to the composer's mind at the moment of musical creation".

Improvisation has not only been reported as a key constituent of audiences' experiences of live performance. Moreover, it has been argued that in some practices improvisation can strongly differentiate the improviser's experience of performance from that of the non-improvised performer. Sawyer (2000) noted that the improvising musician experiences a performance as an act of "problem-finding rather than problem-solving". Instead of approaching a performance with the goal of completing the task of playing a piece, the practice of music making is seen as a conduit through which the improviser might discover inspiring challenges and problems to solve creatively. In this respect, Sawyer draws upon Collingwood's (1938, p. 15) distinction between art and craft, suggesting that the "distinction between planning and execution" present in the performance of a composition makes the act of non-improvised performance akin to craft and the act of improvisation "art proper".

Central to this notion of problem finding is the idea that the improvisational performer enters into a dialogue with elements of the environment (e.g. other performers or their materials) in order to bring about the resulting performance (Sawyer, 2000). A recent study of the practices of jazz musicians found that such a dialogical, problem-finding approach to musical performance imbued performances with experiences of "surprise" and "not being in control", which

were described in positive terms. Such experiences were found to arise from a visceral, non-conscious state where the performer engages in the creation of music at a deeper level than the performer reproducing a composition might (Sawyer, 2009).

Gould and Keaton (2000), however, questioned the position that improvised and non-improvised performances are ontologically different. They argued that the performance of even the most meticulously inscribed musical score would involve a degree of interpretation, for example, "the precise realisation of dynamics, rhythmic subtleties, timbre, intonation and articulation". Such interpretation is said to be improvisational by nature, as the performer makes creative decisions during the moment of performance. Furthermore, the performance of a composed piece is said to be subject to inherent spontaneity as its interpretation will be "influenced not only by the artist's preparation" but by qualities arising in the moment of performance, such as the musician's "mood". Instead, they argued that performances should not be classified as either improvisational or not, but rather in terms of the "degree" of improvisation that they involve. If this view is accepted, improvisation arises as not simply a quality of some genres of live performance, but a pervasive quality, that must feature in any understanding of the live experience upon which interaction design might be based.

Gould and Keaton's (Ibid.) analysis also questions whether it is correct to consider spontaneity a definitive quality of all forms of improvisation. Drawing upon the example of a classical musician who deviates from the score, but using a pre-planned sequence rather than something created spontaneously, they argued that improvisation is not an inherently spontaneous act in some situations. It could of course be said that the aforementioned occurrence is not an example of improvisation, but rather a more traditional alteration of a composition, as the actual compositional creativity occurred before the performance. However, the example given questions whether the kinds of general theories of improvisation uncovered by this review (i.e. those that might suggest spontaneity is a definitive or pervasive quality of all improvisational performances) will provide a sufficient basis to design in response to what is evidently a complex and varied quality of the live experience.

The position of spontaneity as a ubiquitous quality of improvised performance is further called into question by the pre-conceived ideas and materials that have been observed as essential to many forms of improvised performance. Alperson (1984), for example, acknowledged that improvisational performances rarely come from nothing. Rather, jazz performers were said to draw upon both "a personal repertoire of phrases" and a set of "rules" imposed by the genre within which the work is situated to guide their creative decisions in the moment of performance. Furthermore, Gould and Keaton (2000) argued "to improvise successfully, one must have a total familiarity with the language that makes up the stylistic character" of the genre; thus, putting forward a position that many forms of improvisation take place in, and rely upon, the context of a musical, or other genre specific, tradition.

Sawyer (2009) classified the influence of pre-conceived ideas and materials on improvised performance in terms of those relating to the domain, such as the rules and traditions of a genre, and those relating to the individual, such as a personal style or repertoire of clichés. His analysis of improvisational jazz performance found that musicians felt a tension between their reliance on these factors, for reasons such as coping with the increased cognitive load required to improvise, and the ability to innovate. Overuse of clichés, for example, was found to have a negative influence on the results and experience of creativity.

The discussion so far would seem to suggest that improvisation is an exclusively insular activity, which is completed by a lone performer, isolated on a stage. However, this is far from the truth. In many cases, improvisation is situated and entangled within an environment, which must be configured in such a way for improvisation to take place successfully. For example, Kubacki's (2008) survey of jazz musicians found that they struggled to improvise in front of audiences who were not tolerant of mistakes and open-minded to something other than the structure of popular music. Alperson (1984) also found that audiences of improvised performances must adjust their "listening habits" to accept a level of error that would be considered unacceptable in more conventional music performances.

Similarly, Fischlin (2010) described how improvisational theatre performances could be staged in order to introduce elements of the unexpected

and randomness into the environment, so that actors might be presented with inspiration for their performances. Sawyer (2009) described such qualities as "interactional influences", which include additional characteristics such as the social context of a performance (e.g. a jazz club vs. a wedding) and the presence of other musicians with whom to collaborate. Moreover, in an earlier paper, Sawyer (2000) hailed the importance of collaboration with other performers, stating that, in the context of improvised theatre "no one actor can generate a performance alone; instead, the actors have to rely on the group collectively to generate the scene through dialogue". Such environmental influences, be they related to the location, audience or collaborators of performance, all arise as factors that affect the performer's action and experience, and as such force themselves to the forefront for consideration in the design of interactive systems for live performances that might involve improvisation.

Whether spontaneous, collaborative or reliant upon a particular situation or environment, it is clear that improvisation is an essential quality of audiences' and performers' experiences of many genres of live performance. Therefore, it is likely that interaction designers addressing live performance will be faced with a multitude of practices that demand the support, enhancement or at least sensitive consideration of improvisation. However, it is clear from the brief review presented in this section that the development of one definition or understanding of improvisation, upon which designs can be based, is unlikely. Rather, it can be seen that the practices and experiences gathered under the term improvisation can vary substantially; for example, from the restrained and scripted, to the spontaneous and open. Therefore, it is argued that designers wishing to consider improvisation in their practices must not rely exclusively upon abstract discussion of the phenomenon, such as that presented here. Rather, in-depth and specific understandings of how such issues of improvisation relate to particular genres and practices should be developed to provide a more expedient grounding for design.

2.5 Presence

The dimensions of live performance discussed so far have related primarily to the temporal simultaneity of a performer's actions and their reception by an audience. It has been seen that transience, variation and improvisation have traditionally

relied on an audience experiencing a performance as it happens in time. However, those attending live performances have traditionally not only shared in the moment of performance, but also its location. Perhaps the most fundamental consequence of such co-presence is the visible relationship that arises between performer and audience. While this relationship has of course been traditionally essential to visual performing art forms such as theatre and dance, seeing a performer on a stage plying their trade has been credited as having a significant effect upon the experience of a performance, which extends beyond the spectator's basic ability to view its visual aspects.

Presence stands out as a particularly important issue in the discussion of live music, where the visible presence of a performer, while technically incidental to the music produced, is continually lauded as a valuable trait of performance. A common theme that runs through such debate is the audience's apparent desire to gain an understanding of the relationship between a musician's actions and their resulting effect on the performance. Wechsler (2006) associated this aspiration with basic human intrigue, suggesting that audiences will be "naturally curious" about how a performance was done and therefore, a perceptible relationship between action and effect would seem to be a requirement for a successful performance.

It has been argued that a fundamental quality of this relationship is the visibility of the effort made by the performer. Tanaka (2000) argued that audience members perceive the effort invested by a performer in terms of basic physical mechanics; for example, where the exertion of greater physical force might be expected to result in a louder sound. Furthermore, Schloss (2003) described how the audience's ability to see "visible effort" being made by a musician is an appealing and attractive quality of live performance as it demonstrates commitment.

In close relation, the technical skill of the performer is also regarded as an important quality of an audience's experience of a live musical performance. Schloss suggested that this is not surprising, as live performances are often attended with the intent of experiencing an activity "that the audience cannot do themselves" (Ibid.). Similarly, Gracyk (1997) described the "undeniable pleasure in being in the presence of someone displaying great talent", experienced by the

audiences of musicians who have achieved virtuosic ability with their instruments. However, he warned that a visible display of technical skill does not lead inevitably to an enjoyable performance, recounting "tiresome" performances that were defined by the difficulty of the piece played.

Central to the discussion of visual presence in live musical performance, are the physical gestures that the musician makes toward their instrument. Historically, gesture has been an inherent quality of live musical performance. Acoustic instruments by their nature require physical gesture on the part of the performer, which excites a material (e.g. a string) in order to produce sound. Tanaka (2000) referred to this as the "mechano-acoustic coupling" between instrument and performer. As this relationship between musician and acoustic instrument is innately grounded in physical gestures, which the audience are familiar with from their everyday interactions in the world (e.g. "blowing", "striking" and "rubbing"), the relationship between the actions of the musician and the sound produced will more often than not prove legible to audience members (Schloss, 2003). Such a perceptible relationship between physical gesture and sound has been observed to allow audience members to "ground what they hear" and, therefore, prevent them from becoming "confused, lost, or even bored" by the performance (Stuart, 2003).

The requirement for a legible relationship between the physical actions of a performer and their resulting effects does not appear to be limited to musical performance. Wechsler (2006) reported a similar phenomenon when reflecting upon the use of motion tracking to allow dancers to control audio and video during live performance. Therefore, it is suggested that a perceptible relationship between action and effect might prove to be an essential constituent of the experience of a broad range of live performances that involve the use of tools or instruments.

Further accounts suggest that the role of gesture in live performance extends beyond the purely functional and mechanical operation of an instrument. Arfib, Couturier and Loïc (2005) categorised musical gesture into two parts; a skeleton, the "biological" action required to produce sound, and a body, the adjoining qualities of movement that relate to expression and the conveyance of emotion. Reeves, Benford, O'Malley and Fraser (2005) described a similar

phenomenon in the context of performative interactions with user interfaces, as "non-sensed actions". Performers were said to "often gesture artistically 'around' their direct manipulations of the interface, performing distinctive movements prior to or following on from the actual moment of interaction" in ways that had no direct bearing or effect upon the operation of their tools of performance. Such "non-sensed" gestures were associated with the theatrical "amplification" of action with the aim of making a performance "more expressive" (Ibid.). Tanaka (2000), however, argued that such "non-essential" gesture provides more than theatrics, which are performed with the aim of enhancing the spectacle of performance alone. Rather, in his own practice, ancillary musical gestures, while not directly affecting the mechanical operation of the instrument, were found to be a "musically vital element that directs musical flow, phrasing and articulation".

The advent of digital technology in performance allows the link between physical gesture and the production of sound, or any other media for that matter, to be severed. In some cases, this break comes about where the prospect of gesturally controlling the computational processes creating sound is impossible, leading to, for example, taped performances (Zadel and Scavone, 2006b). While in other examples, performances have naturally embraced the more subtle gestural interaction of the laptop computer that has come to dominate the performance of digital music (Cascone, 2002). However, in both cases the legible relationship between the performer's actions and their effects is often lost, along with the values of presence it brought to the audience's experience of performance. This challenge has been coined the laptop-performer problem by many, as it is characterised by the image of a performer hunched behind the screen of a laptop.

The visible relationship between audiences and artists at live performances has not only been associated with the gestural actions of the performer, but also more subtle and delicate qualities of engagement. As was argued in the previous discussion of improvisation, the existence of the performer's creativity in the presence of the audience is an essential quality of many live performances. The co-presence of performer and audience allows for the observation, and therefore potential engagement with, the creative process of the performer (Gracyk, 1997). Gracyk considered the existence of such a perceptible creative process to be the

differentiating factor between live and recorded music, as the former experience is one of creation and the latter is simply recital.

Similarly, Wechsler (2006) found that the most satisfying performances were those where the performer could be seen to be in an apparent creative dialogue with the tools of performance. Furthermore, by studying the differing audience reactions to a script represented as both a film and a play, Barker (2003) found that those who were co-present with the actors in the theatre felt a heightened sense of moral engagement with those acting out the script. The close proximity of the actors and the audience was found to make spectators feel personally related to, to care for, the performers and as such inspired a feeling of obligation amongst audience members to make the effort to engage more deeply with what the performers were attempting to express or convey.

Auslander (2008, p. 40), however, warned against discussion of presence in live performance in terms of the visual relationship afforded between performer and audience alone, by pointing out that televised versions of live events commonly offer a far superior view of the performer (e.g. through close-ups or replays) than that experienced by attendees of the actual event. In response to Auslander's critique, Dixon (2007, pp. 127-130) argued that while the televisual can provide technically superior visual presence of, and immediacy with, a performer, there must be differing qualities of the experience of "being there" that drive the continued existence and popularity of live performances.

Dixon posited that there are particular values of experience associated with the habitation, and sharing, of a physical site of performance; whether that performance is a traditional live event such as a play performed by live actors in a theatre or a mediatised one such as a screening of a film in a cinema. For example, the co-presence of actor and spectator in live theatre is said to have a bearing on the audience's behaviour, or at least expected behaviour, during the performance; hence, it being inappropriate to eat popcorn and engage in the quiet conversation, as one might do at the cinema, in the presence of actors at the theatre. Furthermore, the experiences of viewing a film at a cinema and on a TV set at home are discussed in terms of differing atmosphere and senses of ritual and event. However, like Auslander, Dixon warned against the assumption that "corporeal" co-presence will yield a superior experience for audiences, mentioning his

experiences of “nights of crushing, excruciating boredom at the theatre” despite their live setting (Ibid., p. 137).

The notion of presence stands out amongst the dimensions surveyed, as being of particular concern for interaction designers. The laptop-performer problem offers a concrete design challenge that interaction designers considering live performances such as electronic music might directly grapple with. In fact, this design problem has received considerable attention amongst previous interaction design for live performance (examples of which are reviewed in the following chapter). However, it is hypothesised that designers seeking to support or otherwise engage with notions of presence in live performance might need to look beyond simple responses like increasing the visibility of the performers’ interactions. Instead, it is argued that efforts must be made to explore the subtle and sometimes conflicting qualities and experiences that have been shown to underpin the visible and corporeal presence between artists and audiences, across different genres of performance.

Such an approach to design might involve exploring the possibility of an abstract and ambiguous visible relationship between a performer’s actions and their effect, which is posed by the incursion of digital technology into live performance. For example, Reeves, Benford, O'Malley and Fraser (2005) highlighted how configuring the visibility of the manipulations and effects of a performer’s interactions with technology might imbue a spectator’s experience with qualities such as suspense, magic and secrecy. In this way, interaction designers might be able to exploit the qualities of digital technology to create novel and innovative experiences relating to presence in live performance, rather than simply seeking to retain or reinstate those traditionally associated with the domain.

The impact of digital technology on notions of presence in live performance has been shown to extend beyond audience members’ ability to observe and understand performers’ actions. Virtual reality, augmented reality and communication technologies have led to the development of “mixed reality” performances that span multiple geographical locations and both physical and virtual spaces (Benford and Giannachi, 2011, p. 27). For instance, Can You See Me Now was a mixed reality performance “in which online players [were] chased

through a virtual model of a city by 'runners' (professional performers equipped with GPS and WiFi technologies) who [had] to run through the actual city streets in order to catch the players" (Benford, et al., 2006). Mixed reality performances such as Can You See Me Now demonstrate how technology can support the development new relationships between audiences and performers, where physical co-presence is exchanged for, or augmented with, technologically mediated connections between multiple physical and virtual spaces.

Such new forms of audience-performer interaction may require careful design if a sense of connection and engagement is to be established between performers and audience members who are spread across multiple physical and virtual locations. In the case of Can You See Me Now, such a connection was established by allowing audience members to listen to performers communicating using their *walkie-talkies*. The creators found that allowing online audience members to listen in to the performers' conversations established an essential connection between the representation of the performers in the model virtual city and their actions within its real physical counterpart (Benford and Giannachi, 2011, p. 33). In another example of technology-mediated performance, Desert Rain, a sense of presence in a virtual performance space was established using a "traversal interface". During this performance audience members explored a virtual space that was projected onto a curtain of fine water spray. At the midpoint of the performance, they were asked to step through this curtain of water to find a physical mock-up of the virtual space that they had been interacting in (Koleva, et al., 2001). This symbolic traversal from real to virtual was designed to reinforce the sense that an audience member was in the virtual space and, hence, co-present with virtual aspects of performance (Benford and Giannachi, 2011, p. 133).

2.6 Community

Another widely acknowledged component of the live performance experience is the sense of community that arises between those who are co-present in a performance space. Wechsler (2006) identified three categories of social interaction that exist within a performance space: between performers, between audience members and performers, and between audience members. The first of these has already been discussed in terms of the dialogical collaborative

interaction, which occurs between improvisational musicians. Here, the following two categories are addressed in turn.

Interactions between audience members and performers have been observed to be an important aspect of many forms of live performance. One particularly compelling example of interaction between a performer and their audience can be seen in DJ performance. Gates, Subramanian and Gutwin (2006) explored the DJ's perspective on audience-performer interaction, through a series of interviews with professional "club DJs". A primary finding of this study was the observation that DJs passively watch audience members' reactions to particular aspects of the music that they are playing, with the aim of tailoring their performance to present "a creative mix of music that balances elements of excitement, energy and surprise". While the DJs interviewed demonstrated a desire to respond to, and hence please, audience members through their performance, the notion of more active interaction through taking requests for specific songs was strongly resisted. Requests were often seen as unwanted intrusions, which questioned the DJ's creative and stylistic decisions and their "authority on the specific musical style they were hired to play".

In other forms of performance, interaction between audience members and performers can be seen to be more direct and active. For example, a comedian will often make a spectator the subject of a joke; while in street performance passers-by will often be invited to participate or assist with the show (Gardair, 2011). However, it has been questioned whether the interactivity exhibited in such performances is authentic, or whether it is pre-planned and staged to create an illusion of participation amongst the audience (Auslander, 2008, p. 69). For example, a stand-up comedian might use interaction with an audience as pre-text to the recital of a planned phase of his routine, as opposed to a means of spontaneously improvising novel material. The use of digital technology in live performance would, however, seem to be leading to the development of performances that do offer audience members the opportunity to have genuine interaction with, and control of, aspects of a show. For example, a number of prototypical applications have been developed that use mobile and embedded sensor technologies to allow audience members to directly interact with both DJs

(Hromin, et al., 2003) and VJs (Engström, Esbjörnsson and Juhlin, 2008) during live performance.

Regarding interaction between audience members, Couldry (2010) argued that a live performance is defined by the sense of connection that audience members feel to the reality of an event. A central notion of his theory was the "shared attention" to such realities, and subsequent sense of connectedness and community, which comes about amongst audience members sharing in the experience of a live event. Similarly, Gracyk (1997) considered the "social event" of the performance space to be, alongside the visual relationship between audience and performer, one of two factors that differentiate live and recorded performances. However, he warned that while a live performance might be a superior social event to many other situations, a definition of liveness on such grounds alone "runs the risk of making the [performance] ancillary to the social event". Auslander (2008, p. 65) reinforced this view, arguing that the sense of community amongst audience members at a live event is not a quality of the live performance itself, but is rather something that "arises from being part of an audience" and therefore could be just as easily experienced by those sharing in the consumption of a recording.

A number of examples of mixed reality performance highlight how mobile devices and other communication technologies can be utilised to foster new forms of community between audience members, and between audience members and performers, at live events. For example, Uncle Roy All Around You was a live street performance that brought together audience members and performers who were both online and on the streets of a city "in search of an elusive character called Uncle Roy" (Benford, et al, 2004). Street players were guided through a real city toward the location of Uncle Roy, with clues sent from the orchestrators of the performance. Additionally, online players journeyed through a virtual representation of the city to find information that would assist the street players with their search. Uncle Roy All Around You introduced a community dynamic to live performance, where audience members were no longer a passive group of co-present spectators, but active collaborators in search of Uncle Roy. As a result, the creators of Uncle Roy All Around You were able to blur traditional roles of audience and performer and construct a situation where audience members found

themselves performing to, and spectating, other audience members, rather than only professional performers (Benford and Giannachi, 2011, p. 42).

A second example, the Fairground Thrill Laboratory, also highlights how the careful use of technology can allow spectators to become performers and consequently, move away from traditional notions of community in live performance. During the Fairground Thrill Laboratory performance, riders of a fairground attraction were placed in a telemetry system that captured acceleration data and biosensor data and a live video feed of their faces (Schnädelbach, et al., 2008). The output from this telemetry system was displayed to those queuing to ride the attraction. The creators of the Fairground Thrill Laboratory found that wearing the telemetry system gave riders a "license to perform"; encouraging them to "express themselves freely and sometimes extremely" and, in some cases, commentate their experience during slower periods (Benford and Giannachi, 2011, p. 177).

Sheridan, et al. (2005) explored the changing roles of, and relationships between, audience members and performers that arise in such examples of digitally mediated performance. A "Performance Triad Model" was developed that identified both the active and passive interactions that occur between the observers, participants and performers of a show. Most notably, Sheridan's work introduced the notion of "Wittingness", the extent to which "the individual (or group) has accepted by choice or without reluctance to interact (or to not interact)" in a performance (Sheridan, Bryan-Kinns, and Bayliss, 2007). This concept broaches the idea that participation in a digitally mediated performance, and the community surrounding it, may not always be a conscious or consensual act on the part of the spectator.

2.7 Reflection on the Dimensions

In this chapter, a number of dimensions of live performance have been identified and discussed. These dimensions provide an initial understanding of issues that will be of principal concern to interaction designers wishing to design technologies for both traditional and emergent forms of live performance. The issues uncovered can be seen to not only relate to performers' functional use of technology. Rather, they address a range of subtle and complex qualities of the live experience, which

have the potential to be affected by the design of interactive technology. Furthermore, the discussions of transience, variation, presence and community presented highlight how traditionally fundamental qualities of the live experience can be complicated and called into question by the use of interactive technology in performance. For instance, the discussion of the dimension transience highlights how careful design might be required if a sense of ephemerality is to be invested in performances that are based around communications technology and recorded media. The prevalence of these kinds of complex and experiential issues suggests that if interaction design for live performance is to engage with and enrich the domain, approaches must be employed that are sensitive to not only live performers' functional use of technology, but also the relationship between technology and both artists and audiences' experiences of live performance.

Moreover, while each of the dimensions addressed issues that are common to different forms of live performance, it can be seen that in many cases their relationship with different genres and practices are strikingly divergent. For example, the discussion of improvisation illustrated that it affects a broad range of different genres of live performance and individual performers' practices in often-conflicting ways. While the notion of spontaneity was seen to be central to the different accounts of improvisation discussed, the act of improvising itself was found to involve a range of different practices that included: free-form compositional creativity during the moment of performance, the *bricolage* of pre-formed clichés in response to the actions of other musicians and the pre-planned inclusion of a composed deviation from the score in a performance of a piece of classical music.

Sengers (2006) and Boehner et al. (2008) have argued that attempts to design in response to general definitions of the kind of complex and subtle issues uncovered by the review might result in designs that exchange consideration of the inherently idiosyncratic qualities that underpin people's experiences for unfulfilling design responses that attempt to suit all. Consequently, the dimensions developed in this chapter highlight a possible inadequacy of approaches that might focus exclusively on generalized definitions and rationalisations (e.g. such as those discussed in the dimensions) as a means to identify, describe and understand the complex qualities underpinning experiences of live performance and their

potential relationship with design. Therefore, it is argued that if interaction design is to engage with the issues uncovered in this chapter, design strategies must be followed that explore the individual and idiosyncratic manifestation of the dimensions in specific genres and practices of live performance, rather than relying on general definitions and theories alone.

The subtle, complex and divergent nature of the issues raised by the dimensions highlights the challenging nature of live performance as a space for interaction design and raises questions about what approaches might be appropriate for supporting designers in responding sensitively to the domain. In some cases, designers might be able to employ the dimensions presented as insight to guide and inspire design. For instance, a designer considering performer-audience interaction in nightclubs might choose to restrict the agency given to audience members, in response to the account of DJ practice given by Gates et al. (2006). However, the divergent interpretations of issues found amongst the small number of performances and genres examined, suggests that opportunities for drawing such direct and generalisable insight from the dimensions will be rare.

Benford et al. (2009) have argued that a more fruitful approach to develop generalizable design insight from accounts of live performances might be to employ them as frameworks to guide the development of more in-depth and specific understandings of particular forms of live performance. For example, the different perspectives on presence in electronic music performance identified might be used as the starting point for a set of interviews, or a conceptual framework to assist analysis, when attempting to develop an empirical understanding of the role of presence played in a particular genre of performance, upon which design might be based. Given the idiosyncratic nature of the issues uncovered by the review, it is argued that the success of such an approach might hinge on the possibility of the designer developing an understanding of how issues relate to particular genres and individual practices of live performance.

It is hypothesized that a focus on McCarthy and Wright's (2004) experience-centred design, and its central notion of "felt life", would provide a particularly appropriate means to achieve this goal. McCarthy and Wright posit that our experiences of interacting with technology cannot be understood through abstract theories and rationalisations, such as the dimensions presented in this chapter.

Rather, they argue that design should consider how technology is lived and felt in people's experiences of their actual lives and practices (Ibid., p. 48). It is argued that the adoption of such an idiographic, experience-centred perspective when trying to understand, and design in response to, the kind of issues uncovered in this chapter, would allow interaction designers to respond to issues affecting live performers as they are embodied in their actual practices. Consequently, such a focus might circumvent the abstraction and codification of experience that might arise if designers attempt to design in direct response to the abstract accounts of issues affecting live performance presented in the dimensions.

2.8 Conclusion

In this chapter, previous discussion of live performance in fields ranging from theatre studies to interaction design was surveyed. A number of dimensions were developed from this review, which identify and describe key issues affecting both artists and audiences' experiences of live performance. The dimensions developed in this chapter form the basis of an initial understanding of live performance, which will be built upon throughout the empirical, methodological and design-led strands of the research presented throughout the remainder of this thesis.

Most crucially, reflection upon these dimensions uncovered the subtle and experiential nature of the issues that will be faced when designing for live performance. The varied and often conflicting relationship between these dimensions and different forms of live performances emphasised the need for an idiographic and experience-centred approach to interaction design, which considers issues of live performance as they are embodied in the lived and felt experiences of specific performances, performers and audiences.

CHAPTER 3

Design Strategies

3.1 Introduction

In the previous chapter, a number of issues that affect the experience of live performance were identified and discussed. This discussion provided an initial understanding of issues that would be of principle concern to those designing interactive technology for live performance. The subtle, complex and idiosyncratic nature of the issues uncovered illustrated the need for idiographic approaches to design for live performance, which enable the interaction designer to consider and respond to both audiences and performers' lived and felt experiences of live performance.

In this chapter, previous strategies employed in the design of interactive systems for live performance are reviewed. This review does not attempt to identify and discuss all approaches to interaction design for live performance. Rather, four widely adopted strategies employed in the design of interfaces for live performers are identified and discussed, in order to highlight their relative strengths and weaknesses. When evaluating the strategies, a particular focus is placed on the extent to which each supports the designer's engagement with the kinds of subtle *issues of experience* identified in the previous chapter. It is anticipated that this discussion will provide valuable insight to interaction designers who are exploring different approaches to designing for live performance. Moreover, the understandings developed provide grounding for both the methodological and design-led research presented in the remainder of this thesis.

The design strategies discussed are categorised in terms of the primary strategy by which the designer proposes a design in response to a particular

challenge, issue or motivation. This scheme of categorisation aligns with the pragmatic consideration of design as a process of dialogical engagement with both ideas and materials, adopted throughout this thesis (Schön, 1991, p. 78). The four strategies surveyed are remediation and technology-inspired, autobiographical and human-centred design.

This review is presented with two caveats. Firstly, while a range of interfaces designed in both commercial and artistic contexts are addressed; designs proposed in an academic context form the backbone of the discussion. This focus was a practical choice, as academic papers were more often found to provide detailed accounts of the processes employed by their designers. Secondly, this chapter does not attempt to provide an exhaustive review of all designs for live performance, which might exhibit qualities of each strategy. Rather, a number of designs have been carefully selected to exemplify particular qualities of the strategies discussed.

Reflection on the strategies surveyed suggests that a design approach that draws qualities from autobiographical, human-centred and technology-inspired design should be adopted in the experience-centred design research conducted throughout the remainder of this thesis.

3.2 Remediation

Bolter and Grusin (2000) describe remediation as the process through which new forms of media imitate, enhance and supersede the qualities and functions of their predecessors. In an interaction design context, the notion of remediation can be used to identify a design strategy where the qualities and functions of a design from an existing technological context (e.g. the analogue recording studio) are used to guide and inspire designs that exploit particular advantageous qualities of a novel technology (e.g. the laptop computer).

Remediation has proven to be a widespread, and extensively successful, strategy for the design of interactive technology. For example, the desktop metaphor utilised in the user interfaces of today's popular operating systems can be considered to remediate the artefacts on and around a traditional desk. In this section, a selection of commercial designs and research prototypes that have resulted from a remediation design strategy are discussed.

3.2.1 Replicating Existing Design

Reason (Propellerhead, 2012) is a software package for musical production and live performance, which is a particularly strong example of a design that has resulted from a remediation strategy. The design of Reason's user interface (Figure 2) directly imitates both the visual aesthetic and function of a rack of hardware instruments, such as those found in an analogue recording studio. The user is able to control these instruments, to produce and manipulate sound, by interacting with graphical representations of the knobs, sliders and buttons found on their physical counterparts. Furthermore, by switching to a view of the rear of the rack, the user can make connections between devices using virtual representations of cables, which look and behave like their physical equivalents. By representing the traditional hardware set-up of the musical recording studio virtually on the performer's personal computer, the Reason user interface is said to provide the same look, function and sound, without the problems of cost and logistics that would make the use of such instruments problematic for most musicians (Ibid.).

Figure 2: Front (left) and rear (right) views of Reason's rack user interface

Remediation has proven to be a particularly popular strategy employed by those designing digital tools for DJ practice. In fact, the majority of commercial software packages for digital DJing (i.e. those that allow the DJ to perform with digital audio files rather than analogue media such as vinyl records) appear to have resulted from a remediation strategy. Traktor Pro (Native Instruments, 2012), Virtual DJ (Atomix Productions, 2012), Cross DJ (MixVibes, 2012), and the open source Mixxx (Andersen, 2005), all exhibit user interfaces that mimic the iconic and ubiquitously adopted tools of the vinyl DJ (i.e. record decks and a mixer) on the screen of a laptop computer (Figure 3).

Figure 3: Commercial DJ software Traktor Pro (top-left), Virtual DJ (top-right), Cross DJ (bottom-left) and Mixxx (bottom-right)

By replicating the traditional tools of DJ practice, such interfaces provide a means of interacting with digital audio files during live performance, which exploits the DJ's familiarity with the existing tools of their practice while circumventing the requirement for large pieces of equipment and bags of vinyl records to be transported to performances.

3.2.2 Variation and Abstraction

Another example of an interface for DJs designed using a remediation strategy was presented by Lopes, Ferreira and Madeiras Pereira (2010; 2011). The design is based upon the replication of the DJ's traditional hardware setup (i.e. two turntables and a mixer) on a large interactive multi-touch tabletop display (Figure 4). However, unlike the systems discussed thus far, the designers did not aim for an explicit replication of interaction with the turntable alone. Instead, a number of novel interaction techniques were proposed that exploit the capabilities of multi-touch, while in the context of the original turntable design. For example, multi-finger tapping gestures on the cross-fader were designed to afford rapid and precise cutting between tracks.

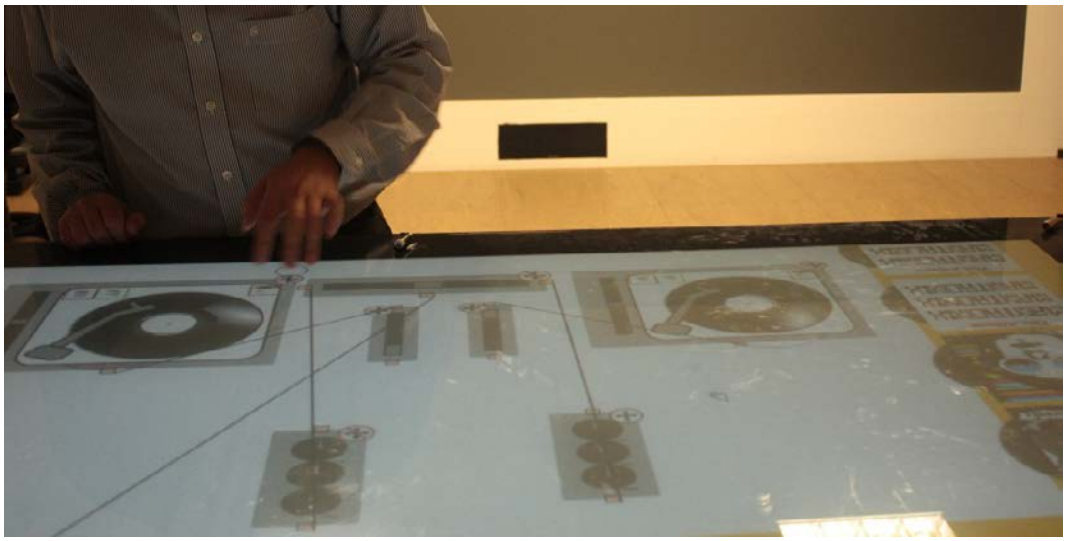

Figure 4: Multi-touch interactive surface for DJing

The design is said to build upon the existing skills of DJs and replicate the hands-on interaction of the turntable, while avoiding problems associated with the traditional setup, such as the need to carry a large number of vinyl records to a performance. When evaluated with 10 DJs, participants reacted positively to the additional interaction possibilities afforded by the system's innovative multi-touch interaction techniques.

Figure 5: The Session (left) and Arranger (right) views of Live's user interface

Ableton Live (Ableton, 2012) is perhaps the most popular tool for live electronic music performance in use today. It is apparent that Live's designers adopted a more abstract stance to remediation, whereby the user interface is reminiscent, but not replicative, of prior hardware devices for musical performance. Live's user interface (Figure 5) draws upon the design of a mixing desk in its session view and a multi-track recorder in its arranger view. However, rather than striving to replicate these devices' interfaces precisely, additional elements and adaptations are incorporated to exploit functionality afforded by digital technology, while still leveraging the user's prior knowledge (Duignan,

Noble, Barr and Biddle, 2004). For example, the session view, while replicating the column-based structure of a mixer, replaces the knobs and dials that would be found on the original physical device with a space within which a composition can be sequenced and played back using abstract representations of digital audio files.

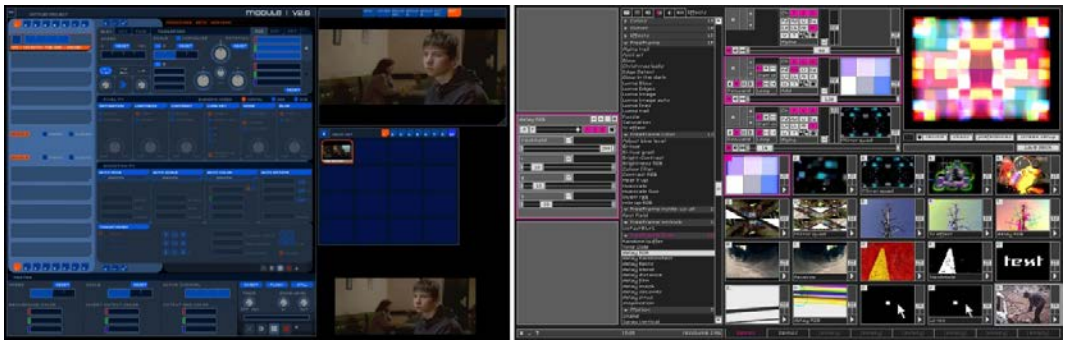

Figure 6: The user interfaces of Modul8 (left) and Resolume (right)

Remediation need not involve the replication of a prior design's visual aesthetic and form. Examples of remediation-based designs that are founded upon the imitation of the abstract functions and workflows of existing technology can be identified also. In the case of VJing, many of the popular commercial software packages, such as Modul8 (GarageCUBE, 2012) and Resolume (Resolume, 2012), represent video media in finite channels, which can be separately faded in and out and have various effects applied (Figure 6). While structurally and visually dissimilar, these interfaces can be seen to mimic the functions and workflows of the hardware video mixers that many VJs used prior to the digitisation of their practices, such as the Roland TR-3 (Roland Corporation, 2012).

3.2.3 Evaluating Remediation-Based Design

Many successful comercial products have been shown to adopt literal replication, or exhibit traces, of designs from prior technological contexts. This is perhaps not surprising, as a remediation strategy offers the interaction designer a number of benefits when designing interactive technology for live performance.

If an interface is based upon a previously sucessful design, it is likely that the support for tasks and activities afforded by the original will persist; thus, resulting in a design that fulfils the functional requirements of the user. Perhaps more crucially, by preserving the visual form and/or workflow of a previously widely adopted device, designs based upon remediation are likely to allow users to

draw upon their prior knowledge and experience. Therefore, learnability, a central principle of usability (Dix, Finlay, Abowd and Beale, 1993), is afforded as a natural consequence of the design strategy. However, the remediation of prior interfaces has the potential to be problematic in terms of usability, innovation and most critically, the extent to which the designer is empowered to engage with the kinds of issues that underpin the experience of live performance.

In the simplest terms, an interface that is based upon the replication of an existing design runs the risk of inheriting not only that design's valuable and well-designed functionality, but also its problems (Duignan, Noble, Barr and Biddle, 2004). This could prove to be a particularly pertinent challenge in the case where the preceding design was primarily forged for reasons of practicality, rather than the needs and experiences of the user. For example, the use of physical cables in a recording studio can lead to a confusing "spaghetti hell" of overlapping wires. However, the design persists, as these cables are required to transmit electronic signals between devices. When these physical cables are remediated in the Reason interface, the problem remains despite the possibility of alternative methods of illustrating connections between devices that might prove more intelligible to the user (Ibid.).

Perhaps a more pressing problem with the use of a remediation strategy in the design of interfaces for live performance relates to the technological context of a design. The things that make a particular design successful might be inherently tied to the technology for which it was originally proposed. Therefore, when detached from that technology and remediated in another, the experience of interaction might be altered significantly. The laptop-based digital DJing tools surveyed reveal a particularly compelling example of this phenomenon in action. The DJ's interaction with vinyl record decks, and to a lesser extent CDJs (compact disc turntables), has been applauded for the performative physical and gestural interaction afforded, in terms of the prominent and visually appealing physical interaction with the turntable and mixer (Beamish, Maclean and Fels, 2004). However, when the DJ's record decks and mixer are remediated in the context of a laptop computer, miniature movements made with regard to an individual hardware device replace this visible physical interaction. Therefore, interactions in the former and latter cases are clearly marked as substantially different, and

degraded, in terms of the audience's ability to experience the performer's interactions; and thus their presence on the stage.

A remediation strategy might also exhibit problems in terms of the level to which innovation is permitted. Most simply, basing design upon replication would seem to be in direct conflict with the notion of novelty and innovation. Innovation leads to deviation, which is of course at odds with the notion of replication. The abstraction and variation evident in some of the examples surveyed (e.g. the design of Ableton Live) could be considered to circumvent such problems by imbuing the design strategy with the potential for innovation. However, if remediation is strictly defined as the imitation of a previously proven design, it could be considered that any innovative decisions exhibited in these designs must have resulted from an alternative design strategy employed in the context of remediation, such as one of those discussed in the following sections.

When considered as a means of enabling designers to engage with the subtle issues of experience highlighted in the previous chapter, further problems with the strategy are evident. A remediation strategy might be considered a design-centric approach to design, as instead of considering the needs and experiences of the user directly, they are addressed at one remove through their instantiation in an existing artefact. In some cases, this may prove to be a highly successful strategy as the new technological context will fit with the old design and, therefore, afford a rich experience of interaction valued by performers and audiences alike. However, such cases would be consequences of luck or coincidence, rather than in-depth engagement with the qualities and values that shape experiences of live performance. Therefore, a remediation strategy can be seen to be unable to equip the designer with the capability to engage directly with the kinds of issues of experience shown to be pivotal to live performance.

3.3 Technology-Inspired

Technology-inspired design shifts the designer's focus from the qualities and functions of previous designs, to the exploration of possible functions, practices and interaction paradigms offered by new technology. In this way, examples of technology-inspired designs can be seen to focus upon the application of emergent technology in design, with the aim of enhancing existing, or proposing novel, forms

and practices of live performance. In this section, the use of a technology-inspired design strategy, in the context of two of the key dimensions of live performance identified in Chapter 2, is explored with the aim of uncovering potentially advantageous and disadvantageous characteristics of the approach.

3.3.1 Technology-Inspired Design for Community

A number of designs have been proposed that utilise novel technology to augment and enhance the sense of community felt between artists and audience members at live performances (Section 2.6). Maynes-Aminzade, Pausch and Seitz (2002) utilised a range of computer vision techniques to track the actions of a cinema audience. While the techniques did not allow audience members to interact directly with the film being presented, they afforded collaborative behaviour between audience members, such as controlling the steering in a racing game by collectively leaning in a particular direction.

Feldmeier and Paradiso (2004) designed compact wireless accelerometer modules, which emit a radio frequency pulse when they are moved with particular vigour. The sensors – which were designed to have a very low cost, less than one US dollar when mass-produced – were given to audience members in a nightclub setting. Pulse signals, such as those generated as audience members danced, were used to manipulate the music playing in the club. When deployed in a series of "interactive raves", it was found that audience members felt a greater sense of "control over the music" than at traditional club performances. The motivation for the design was described as the exploration of the possibility of creating "environments that reflect and react to the collective activity of groups with tens, hundreds or even thousands of participants".

In a similar system, CodeBLUE (Hromin, et al., 2003), audience members wore a belt that was equipped with a wide variety of sensors. These included an infrared proximity sensor; bend sensors for the knees and elbows, an accelerometer to sense movement, a light sensor and a touch sensor. Values from these sensors were transmitted to a base-station, using Bluetooth, and then used to control both the sound and light in a nightclub venue. CodeBLUE was designed to explore the possibility of democratising the practice of musical creation and

performance, so that those without the necessary musical skill or confidence might share in experiences normally reserved for skilled performers.

In these examples, it can be seen that the application of novel technology to issues of community in live performance has led to the proposal of novel and innovative designs, which might form the basis of new and exciting forms of performance. Therefore, the value of novel technology as a mechanism for inspiring innovative design is highlighted. However, when the designs presented are considered in the context of prior studies of audience-performer interaction and participation in a live setting, contradictions with the experiences of these phenomena are apparent. For example, as was discussed in the previous chapter, some DJs have been found to view audience interaction, in the form of requests, as an unwanted distraction that conflicts with their integrity as artists (Gates, Subramanian and Gutwin, 2006). Therefore, systems that leverage wireless sensing technology to input into a performance might prove to be jarring and unwanted by DJs. This conflict might be circumvented if the DJ was removed from the situation, making audience members the sole performers. However, in this case, qualities resulting from the experience of being performed to in a club environment, such as the excitement and surprise felt by an audience member when the DJ brings forth their favourite track in his or her mix, might be lost. Therefore, it is suggested that while innovative, the technology-inspired designs surveyed here, might be inappropriate for many artists and audiences' desired experiences of community in live performance.

3.3.2 Technology-Inspired Design for Presence

Another particularly prominent theme that arises amongst technology-inspired designs for live performance, is the proposal of interactive systems that enhance the visibility, legibility and, therefore potentially, the presence of a performer's actions (see Section 2.5).

Tokuhisa, Iwata and Inakage (2007) designed Rhythmism, an interface for controlling a VJ performance, which allows a performer to control the playback, and effects applied to, video clips by gesturing with a pair of maracas. Particular clips and effects can be selected by placing an RFID tag within one of the maraca-like controllers (Figure 7). Parameters are then affected by performing gestures

with the maracas, which are tracked using an accelerometer and a rotation sensor. The interface is said to afford gestural and physical interaction, which leverages the audience's prior knowledge of interaction with maracas to make the VJ's actions both visible and legible during performance.

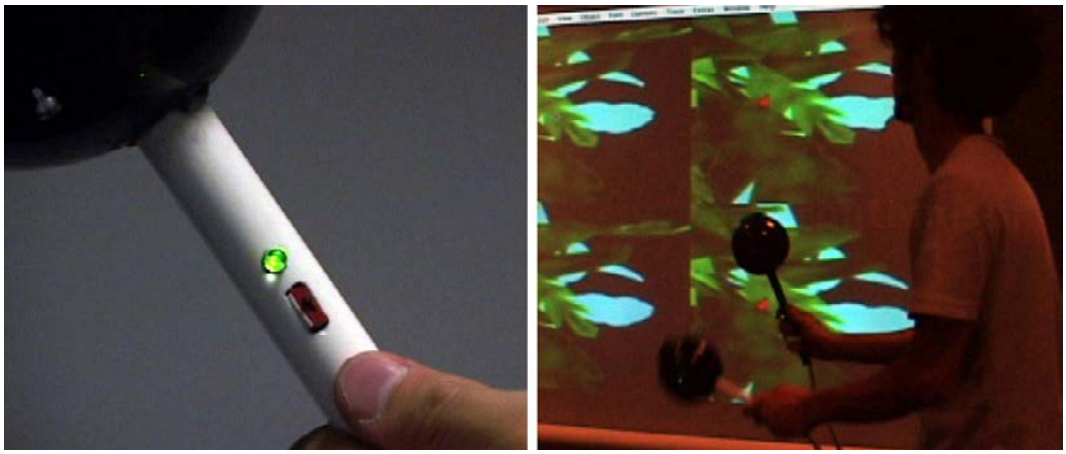

Figure 7: Rhythmism, VJing with a maracas based controller

Zingerle and Freeman (2011) presented the VJacket, a wearable controller for VJ performance. A jacket is worn by the performer, which is augmented with a variety of sensors that are used "to control video effects and transitions, trigger clips or scratch frames" during performance. The interface was designed with two primary goals in mind. Firstly, the designers aimed to enhance the visibility of the VJ's actions and therefore audiences' perceptions of VJing as a "legitimate" performative art. Secondly, it was hoped that the incorporation of the performer's movements directly into the control of the VJ performance would afford the performer more natural and free rhythmic control during performance by exploiting their ability to dance, which is said by the authors to be "the ultimate form of rhythmic expression".

WaveForm (Banerjee, Burstyn, Girouard and Vertegaal, 2011) utilised a motion capture system to track the hands and head of a performer, who was able to perform a range of gestures to control a VJ performance (Figure 8). By affording visible gestural interaction, the design was said to make the audience's experience of a performance more "immersive", than the traditional laptop-based performances commonly completed by VJs. Unlike the previously mentioned systems, not all interactions are controlled using large visible gestures. Instead,

much of the functionality is controlled using an Apple iPad held by the performer, with only select functions utilising gestural control.

Figure 8: The WaveForm gestural interface for VJing

The designs presented here again illustrate how the application of novel technology with respect to experiential qualities of live performance can result in the proposal of innovative designs, which exploit novel tangible, gestural and wearable interaction paradigms. Yet again, however, the designs can be seen to conflict with the practices and experiences of the particular live performers for whom the designs are intended. For instance, previous accounts of VJ practice (Engström, Esbjörnsson and Juhlin 2008; Faulkner, 2006; Spinrad, 2005), and the study presented in the following chapter, highlight it to be a rich art form that depends on the VJ's ability to imbue a performance with particular personal aesthetics or expression, using potentially subtle and complex manipulation of visual media. However, the designs presented here seem to limit the VJ to simplistic one-to-one gestural mappings between the manipulations of a sensing apparatus and the playback of, and application of effects to, a video. While these designs exploit novel technology to amplify the visibility and legibility of the VJ's actions, this would appear to be done at the expense of other values and principles that are crucial to their practice (e.g. the possibility of making complex manipulations of visual media).

3.3.3 Evaluating Technology-Inspired Design

Reflection upon these examples of technology-inspired design suggests that the strategy has a number of advantageous qualities. The designs illustrate examples

of fresh and original forms of interaction that support and enhance existing, and pave the way for the development of novel, forms of live performance. Therefore, the practice of considering the potential for novel technology to shape and respond to issues underpinning live performance (e.g. community and presence) stands out as a valuable means for inspiring innovation in the design process.

However, the examples also demonstrate problems with the strategy, which primarily relate to the designer's ability to consider how the innovative, technology-inspired designs might relate to the lived and felt experiences of the practices for which they are designed. That is to say, the strategy can be seen to provide innovative solutions to issues facing those designing for live performance (e.g. the amplification of the performer's presence on stage). However, while interesting and innovative, the designs resulting from the strategy would seem to conflict with the aspirations and experiences of the artists and audiences who would interact with them *in the wild*. Therefore, it is suggested that the adoption of an exclusively technology-inspired design strategy might result in the failure to consider the kinds of subtle and interrelated issues that were shown in the previous chapter to be definitive of artists and audiences' experience of live performance.

3.4 Autobiographical

Sengers (2006) defined autobiographical design as "the design of technology with respect to details of its designer's personal experiences". In the case of live performance, autobiographical design arises as a particularly prominent strategy. Large numbers of tech-savvy artists can be seen to draw upon in-depth knowledge and experience of their own practices, to design novel and innovative interactive technology for live performance. In this section, a number of examples of the strategy are reviewed, in order to highlight the advantages and disadvantages of the varied forms of autobiographical design that live performers have adopted.

3.4.1 Designing for One's own Practice

Favilla and Cannon (2006) described the design of a series of musical instruments, which they created for the performances of their "Bent Leather Band". The instruments – a Light Harp with laser beams in place of strings and the Serpents, a

series of “double reed” instruments augmented with sensors (Figure 9) – were designed in response to the designers’ personally held notions of “playability”, which were developed through longitudinal participation in improvised ensemble performance practice. To Favilla and Cannon, a playable instrument enables “a balance between the instruments’ expressive potential, responsiveness, quality of feedback, embodiment of the sound and the instruments’ ability to provide the player with an intuitive understanding about the music being played”.

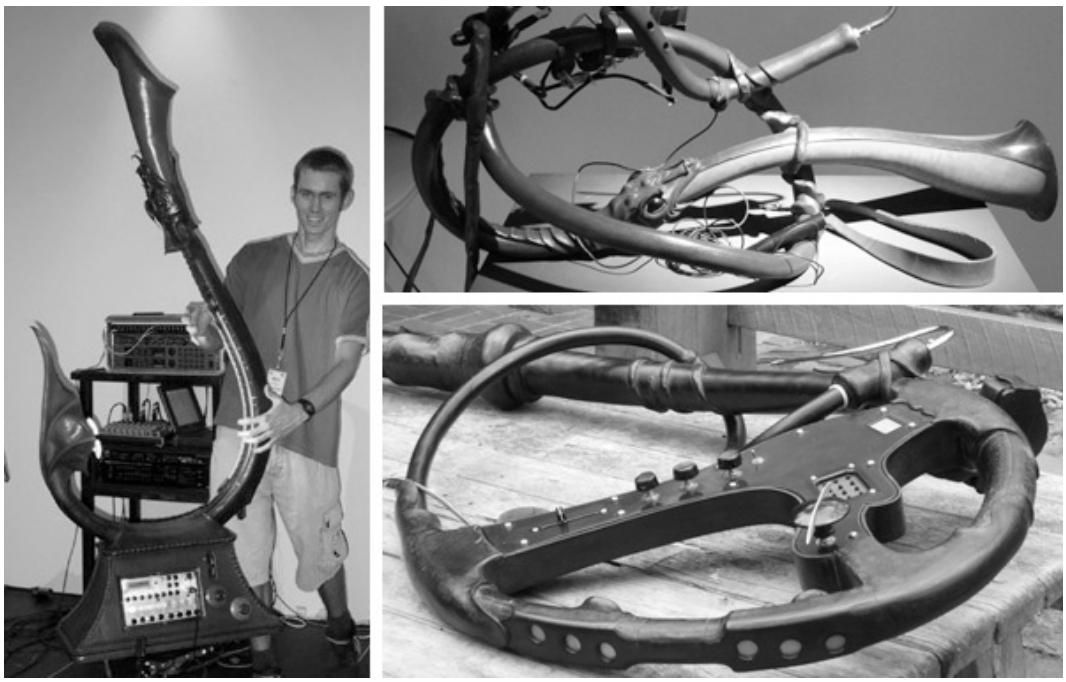

Figure 9: Bent Leather Band's Instruments, Light-harp (left), Serpentine-bassoon (top-right) and Contra-monster (bottom-right)

Rebelo and Van Walstijn (2004) created the Prosthetic Conga, an electronic musical instrument that was designed to afford the kind of intimate relationship with the medium of sound production, experienced by those playing acoustic instruments. The design was based upon Rebelo and Van Walstijn’s view that musical instruments should not be tools that fulfil a performer’s predefined musical intent, but rather – through intimate interaction, akin to prosthesis – should shape and contribute to the performance by facilitating, and entering into, a dialogue with the musician.

The Prosthetic Conga comprises conga drums that are augmented with loudspeakers “to reinforce, damp or add to the acoustic resonances excited by the player, thereby altering the sonic qualities of the instrument”. This allows the

musician to feel physical feedback relating to both their actions and the underlying process of music production when playing the instrument. Thus, the Prosthetic Conga combines the performer's physical interactions and the underlying processes of the performance, resulting in the designers' desired *acoustic-like* playing experience.

Zadel and Scavone (2006) designed Different Strokes, a "freehand drawing interface" for live musical performance. The design allows a performer to draw simple shapes upon a virtual canvas, using either a graphics tablet or mouse. The strokes drawn are associated with sound samples, which are played back as small particles (i.e. icons representing a position on each stroke) re-trace the performer's pen or mouse movements. Different Strokes was designed in response to the authors' frustration with traditional music production software, which was said to involve primarily "piloting" material prepared prior to performance, rather than the live creation of music. The simple sketch-based interface, which is visually similar to a simple paint program, was designed to provide an "efficient way of defining generative control patterns in a performance setting"; therefore, affording creative action "on the fly, on-stage".

Figure 10: Tanaka performs using the BioMuse

Tanaka (2000) described three novel electronic musical instruments that were developed by Sensor Band, a collective of musicians of which he was part. These include the BioMuse (Figure 10), an instrument that responds to muscle

tension using electromyogram (EMG) sensors; SoundNet, a large mesh of ropes that performers climb upon to create and manipulate sound and GlobalString, a set of large strings at different geographical locations, which when plucked vibrate together to form the basis of sound synthesis.

Tanaka reflected upon how his experience of the prolonged, iterative development and "concert performance" of these instruments uncovered qualities that guided their design as musical instruments. Firstly, the importance of instruments having a definitive character, which often arises because of its limits as much as capabilities, was stressed. Such a character was said to not only inspire and enthuse the musician during live performance, but also to make idiomatic composition possible, where the historical knowledge of an instrument's capabilities and limitations is drawn upon in a composition. Secondly, Tanaka found that an instrument must invite the musician to enter into an intimate relationship with its particular qualities, as part of their practice. The possibility of such a relationship was said to depend on the existence of rich feedback with regard to the musician's articulations, which allows for the exploration of the instrument's character during both improvisational performance and composition. Most interestingly perhaps, such an intimate feedback loop between performer and instrument was said to be a prerequisite for virtuosic practice.

Figure 11: The translucent screen (left) and video drum (right) of the Live Cinema Instrument

The Live Cinema Instrument (Lew, 2004) is a novel interface for live cinema, a form of VJ performance that focuses upon qualities of cinema such as narrative. The Live Cinema Instrument was first conceived, using a remediation design strategy, as a Max/MSP (Cycling 74, 2012) patch that allowed two videos to

be mixed, in a manner similar to how a DJ would mix records with turntables and a mixer. However, the final Live Cinema Instrument design was proposed in response to the author's personal experiences of performing with the initial Max/MSP prototype at a series of live events. The final design responded to the author's experience that audiences lacked understanding of his actions during performance. Consequently, a translucent projected touch screen display was used to allow audience members to see the performer's interactions (Figure 11). Additionally, a "video drum", a haptic turntable-like device, was designed to provide the "hands-on, fast, expressive and accurate live manipulations" found to be lacking in the mouse-based interaction of the prototypical design.

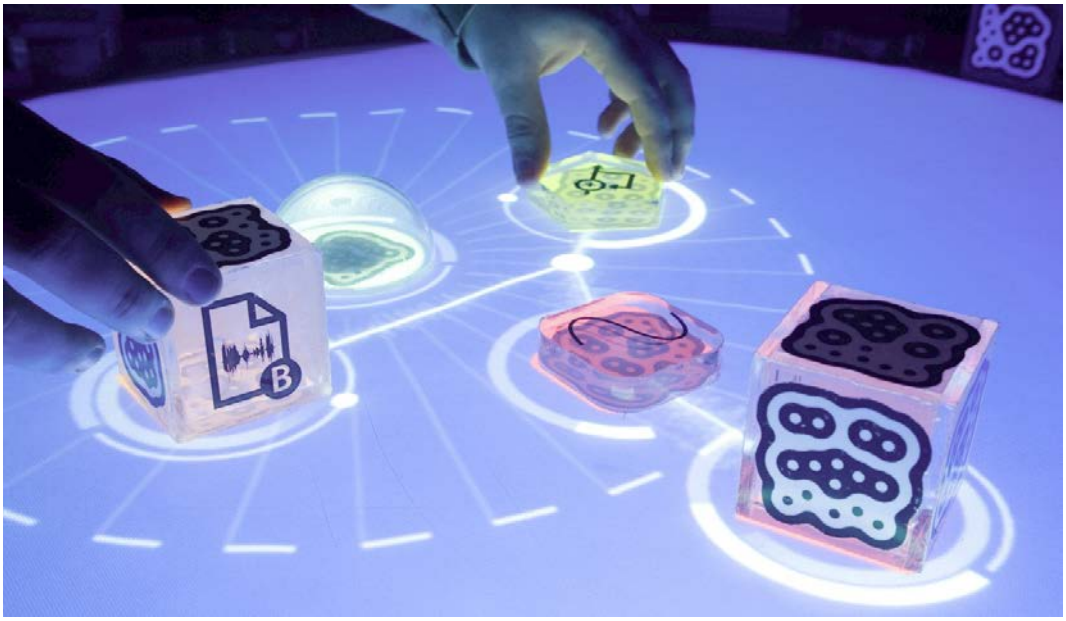

Figure 12: The performers collaborative around the reacTable

One of the most notable and novel interfaces for live performance, resulting from an autobiographical design strategy, is the reacTable (Kaltenbrunner, Jordá, Geiger and Alonso, 2006; Jordà, Geiger, Alonso and Kaltenbrunner, 2007). Musicians performing with the reacTable place a number of small plastic objects on a tabletop, which are tracked using a camera mounted below the translucent table surface in order to determine their type, position and orientation. These parameters are used, in combination with those of other objects on the surface, to manipulate a synthesiser.

The musicians who designed the reacTable had "more than 15 years [of] experience as digital luthiers and computer music performers" (Jordà, Geiger,

Alonso and Kaltenbrunner, 2007). The design of reacTable responded to the challenges that the designers had faced when performing with prior interfaces for electronic music performance, which leveraged interaction paradigms drawn from general desktop computing. Unlike these systems, the reacTable was designed to afford direct, intimate and involved interaction with the sound producing elements of the instrument, which, while a common experience of interaction with acoustic instruments, was found by the authors to be missing when performing with, for example, a mouse. In the reacTable design, this kind of interaction was achieved by directly associating physical objects with the parameters of a synthesiser's sound producing processes (Figure 12). By directly externalising these processes, rather than encapsulating them in abstract metaphors, the designers hoped to allow the musician to be able to constantly monitor "the objects' states and internal parameters" and respond accordingly as part of a dialogue during performance.

Figure 13: Interactive art by Robyn Taylor and collaborators Deep Surrender (left), dream.Medusa (centre) and humanaquarium (right)

The art practice of Robyn Taylor presents a particularly interesting case of autobiographical design. Taylor creates interactive audio-visual art pieces that draw upon both her practice as an artist and her experience as an HCI researcher. Taylor's artistic practice has evolved through a number of interactive live performances, which she designed, developed and performed with over a number of years (e.g. Taylor and Boulanger, 2006; Taylor, Boulanger and Olivier, 2008). Reflection upon the experience of designing and performing with these pieces not only fed into the development of her artistic practice, but also informed her academic research into HCI in public spaces (Taylor, Boulanger, Olivier and Wallace, 2009).

The humanaquarium is a particularly compelling example of autobiographical design in Taylor's practice (Taylor, et al., 2010; Taylor, et al.,

2011). The humanaquarium was designed collaboratively by Taylor, a second artist (Schofield) and an interaction designer (Shearer) to explore the dynamics of participatory performance discovered through Taylor's evolving artistic practice, which included enchantment, engagement and legibility. A humanaquarium performance is centred on a large box, fronted with a transparent acrylic Frustrated Total Internal Reflection (Han, 2005) multi-touch screen. Taylor and Schofield sit inside of the box during performance, while Shearer mingles amongst the audience subtly encouraging participation. As both the performers and audience members touch the glass front of the box, effects are applied to the audio and visual aspects of the performance.

The design of humanaquarium was based initially upon Taylor and her collaborators' prior experiences of participatory performance. However, the design was subtly iterated over multiple performances, so that the experiences of, and interactions between, performers and audience members would meet the artistic goals of the project. The authors describe this dialogical process as "designing from within", which stands out as a particularly relevant concept to the exploration of autobiographical design as the artists' practices develop alongside the design that it has inspired. Therefore, the autobiographical strategy employed in humanaquarium, stands out as not simply the act of proposing a design in response to one's own experiences of live performance practice, but as a means through which both practice and design co-develop.

3.4.2 Evaluating Autobiographical Design

Reflection upon the examples given illustrates the innovative nature of the designs resulting from the autobiographical design strategy, in terms of the extent to which they break away from pre-existing interaction design paradigms and embrace the possibilities of novel technology. Moreover, the designs presented can be seen to respond to subtle and complex issues of their designers' personal and idiosyncratic experiences of live performance. Therefore, it is argued that the autobiographical strategy achieves the kind of idiographic and experience-centred consideration of live performance, which was argued to be essential for the design of interactive technologies that support, enhance and enrich artists and audiences' experiences of live performance (Section 2.7).

Considering the design strategy through the lens of McCarthy and Wright's experience-centred design (2004), might shed some light on the particular qualities of the autobiographical approach that offers designers the ability to engage so expediently with issues underpinning the experience of live performance. Recall, McCarthy and Wright argue that if people's experiences of interacting with technology are to be fully understood, they must not be considered in abstract and objective terms, but rather should be approached in a way that is sensitive to the subjective personal aspirations, desires, histories and other qualities that underpin how they are lived and felt in everyday life. The consideration of experience in this way is referred to as being holistic as, rather than being considered in isolation, people's experiences are addressed in terms of the complex "interplay between feelings, intellect, emotions, behaviour and the physical environment" within which they are embodied (Wright and McCarthy, 2010, p. 14).

By living with the practice designed for, the autobiographical designer is inherently immersed in its experience. Therefore, when designing for their own personal, subjective experience, the autobiographical designer is able to engage with issues of live performance as they are literally lived and felt (Sengers, 2006; Boehner, Sengers and Warner, 2008). Therefore, each design decision can be considered in the context of its interrelationship with the plethora of values that affect the designer's practice. This inherent connection with felt life is argued to be the characteristic that imbues autobiographical design with the holistic engagement with experience observed in the examples presented.

An autobiographical design strategy is of course restricted in two very important respects. Firstly, to conduct autobiographical design, a designer requires in-depth personal knowledge and experience of the practice addressed. As the number of interaction designers who are also skilled and experienced live performers will be limited, it is anticipated that very few interaction designers will actually be able to employ the strategy. This challenge arises as being particularly problematic if the small subset of designers who sit on the parapet between design and live performance are assumed to have an equivalently small subset of the knowledge, skills and perspectives, which might inspire and guide the

development of novel and innovative interactive technology, compared to those possessed by the wider interaction design community.

Secondly, due to the inherently subjective nature of an individual's experience, it is anticipated that autobiographical design might result in intrinsically bespoke designs. It is hypothesised that these designs, while appropriate for designer, might not prove suitable for the practices of others. Therefore, it is argued that autobiographical design might not be a viable strategy for those wishing to develop interactive technologies for adoption by a large number of users (a crucial requirement for any design strategy that might fit into a sustainable business model for the production of commercial interfaces for live performance). However, the widespread popularity of the reacTable, characterised by its adoption by a mainstream musical performer Björk (Jordà, 2008), calls the latter of these concerns into question and, therefore, suggests that designs forged using an autobiographical strategy might actually prove applicable beyond the immediate practice and experience of the designer.

3.5 Human-Centred

The final strategy identified, human-centred design, is characterised by a particular focus upon the people of live performance. Designs forged using a human-centred strategy can be seen to draw motivation, inspiration and guidance from the study of, or engagement with, the needs and experiences of live performers and their audiences.

The examples of human-centred design surveyed differ from the aforementioned autobiographical design strategy, which is of course inherently human-centered, as they are all conducted from an external perspective. That is to say, in the examples given, the designer primarily considers the practice of another person (the live performer) rather than their own. It is hoped that by exploring examples of human-centred design conducted from an external standpoint, the challenges faced by interaction designers wishing to respond to others' experiences of live performance might be identified and understood.

3.5.1 Grounding Design on the Study of Users

Based upon the proposition that "people that attend [nightclubs] should be able to enhance their own and everyone else's experience by adding a personal influence", Kaiser, Ekblad and Broling (2007) designed a system to facilitate interaction between VJs and audience members. The system allows audience members to upload personal visual content using Bluetooth data transfer or a photo booth and scanner positioned in the nightclub. The VJ is then presented with the option to incorporate this footage into their performance, if they deem it appropriate (Figure 14).

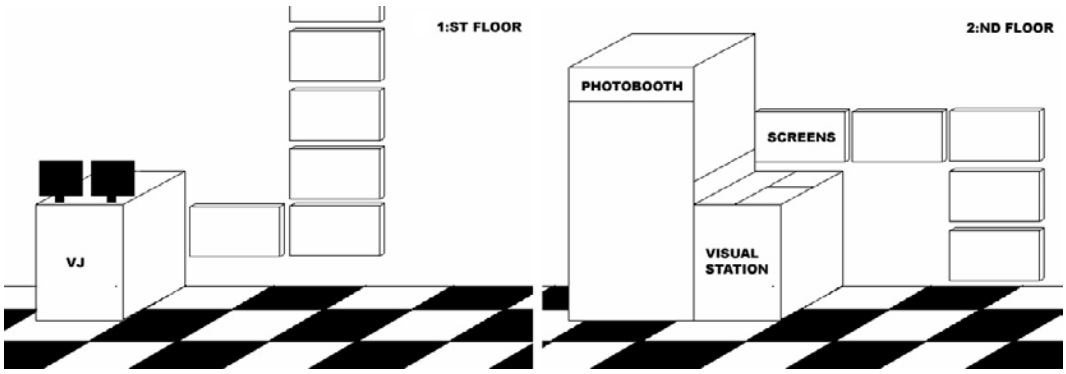

Figure 14: Design concept for an interactive VJ performance system

Like the technology-inspired interactive nightclub systems presented earlier in this chapter, this design would appear to be motivated by the juxtaposition of technological possibility with the designers' belief that club-goers should be afforded some kind of creative contribution to the nightclub experience. However, the design process utilised can be seen to differ from a technology-inspired strategy, as the designers draw upon empirical work by Gates, Subramanian and Gutwin (2006), which articulated unwillingness amongst DJs to open up their performances to audience participation, as a source of design insight.

The consideration of DJs' practices uncovered and articulated in this ethnographic work, can be seen to have led to a design that is sensitive to the desires of particular live performers, by allowing the artist to retain overall creative control of the performance. Therefore, Kaiser, Ekblad and Broling's consideration of an empirical account of a DJs' experience of live club performance would appear to have provided insight into particular tensions of club

performance, which were overlooked by the primarily technology-inspired designs for night club performance presented earlier.

A related system, SwarmCam (Engström, Esbjörnsson and Juhlin, 2008), allowed audience members to create videos on their mobile phones and then transmit this content to a VJ, for potential inclusion in his performance. The design of SwarmCam was also guided by a study of live performers' practices, which involved interviewing nine VJ acts and observing VJs in action during multiple live performances. However, unlike in the previous example, the designers conducted the study, as an integral part of their design process. This ethnographic engagement uncovered a set of characteristics of VJ practice, which ranged from practical interface design requirements, relating to preferences for the display and preview of video material, to an articulation of the VJs' varying aesthetic preferences.

The design of SwarmCam sought to explore the "possible combination of mobile collaborative live video production and VJing". The findings of the designers' study of VJ practice provided two forms of valuable insight during the design process. Firstly, VJ practice was found to offer a unique perspective from which to design novel and innovative uses of emergent technologies for collaborative video production on mobile devices. Secondly, and perhaps more crucially, the understandings of VJ practice developed can be seen to have allowed for the design of a collaborative live video production system that was not only innovative, but was also carefully crafted to relate and respond to a number of crucial issues affecting VJs' potential experiences of performing with the design.

MixiTUI (Pedersen and Hornbaek, 2009) is a tangible user interface for controlling a software music sequencer. In a similar manner to reacTable, in fact using open-source software developed as part of the reacTable project (Kaltenbrunner and Bencina, 2007), physical objects are tracked on a table surface. Samples and effects can be played by placing particular objects on the surface, which are directly associated with files that the performer has loaded into the system prior to performance. The parameters of samples and effects are then manipulated using a separate control object.

The design of mixiTUI was guided by a study of three experienced electronic musicians, which was conducted by the designers. In addition to

interviewing live performers, the designers also conducted a contextual inquiry, a method that involves observing and discussing a person's practice as they take part in it (Wixon, Holtzblatt and Knox, 1990). During these studies, the designers found that much of the creativity in the participants' electronic music practices took place prior to performance. Subsequently live performances often involved little more than "merely pressing play" to initiate a pre-set composition. This situation was found to be unsatisfactory for the musicians in terms of both the experience of creativity in the moment of performance and the audience's perception of the performer's contribution. However, the musicians interviewed valued the automation of particular aspects of their performance (e.g. assistance starting a sample on a particular beat), as electronic music was said to be often reliant upon actions being completed correctly and at precise moments and consequently recovering from mistakes is often difficult.

In response to these challenges, mixiTUI was designed to afford a more creative performance for live electronic musicians, while remaining compatible with the performer's desire to produce samples and effects prior to performance. In this respect, the design focused on supporting the fluid re-arrangement of samples and the application of effects, while avoiding the risk and cognitive load associated with using software that affords creativity live.

3.5.2 Evaluating Human-Centred Design

While there are relatively few reflective accounts of human-centred design for live performance, the examples that do exist demonstrate the potential of the strategy to support designers wishing to engage holistically with issues affecting artists and audiences' experiences of live performance, but from an external standpoint. For example, the design of mixiTUI was shown to offer performers a sense of live creativity, while respecting the desire amongst the musicians interviewed to retain the elements of pre-performance creativity essential to their existing practices. Examples such as this highlight how the close consideration of the motivations, aspirations and experiences of live performers offered by human-centred design, can inform design that is sensitive and supportive of issues underpinning the experience of a live performer's practice.

The examples of human-centred design discussed, therefore, highlight the potential of the approach as a means to support holistic engagement with issues of the live experience in design. However, reflections upon previous attempts to engage and understand experiences of live performance from an external standpoint suggest that interaction designers wishing to adopt the approach may face a number of challenges. For example, when studying the different experience of watching a play as a film vs. as live theatre, Barker (2003) found that audience members struggled to articulate the essence of the experiences that differentiated the two forms of performance. Instead, Barker found that those interviewed relied on general terms and rationalisations of experiences, like "immediacy". Barker argued that, while effectively referring to what had been experienced, these terms did not articulate the qualities at the core of what had actually been felt by audience members during the two performances. Similarly, when studying the practices of electronic musicians, Bertelsen, Breinbjerg and Pold (2007) noted the existence of a "say-do problem", where performers, when interviewed, were found to "rationalize about their practice in a way that [was] largely different from what they actually [did]".

These accounts, suggest that articulation of the kinds of subtle and complex issues that underpin an individual's experiences of live performance might be a problematic activity. Therefore, interaction designers wishing to understand others' experiences of live performance holistically using a human-centred design strategy may be faced with a challenge. That is to say, if audiences and performers are unable to fully articulate their experiences, those conducting human-centred design from an external standpoint will be unable to consider and understand practices of live performance in anywhere near the depth, detail and comprehensiveness that one experiencing those practices first hand might (i.e. the autobiographical designer).

The examination of human-centred design through the lens of Polanyi's epistemology of personal knowledge (1958) has the potential to explain this challenge of articulation. Central to Polanyi's ideas is the concept of tacit knowledge. Polanyi (1966, p. 4) argued that "we can know more than we can tell" and, therefore, there exists knowledge amongst all of us that extends beyond what can be effectively articulated. The classic example of this tacit kind of knowledge is

the riding of a bicycle. While the rider knows perfectly well how to ride their bike, they might struggle to articulate how the bike is actually ridden to a learner (Polanyi, 1958, p. 88).

Polanyi argues that tacit knowledge can be defined in terms of three "characteristic areas" of the "relation between speech and thought" (Ibid., p. 87). Firstly, he describes the "ineffable domain", where the tacit component predominates to the extent that articulation is virtually impossible". Secondly, the case where "the tacit is co-extensive with the text of which it carries the meaning", leads to a kind of tacit knowledge that lies in a person's inability to derive meaning from another's words. Thirdly, the "domain of sophistication", where the "speaker does not know, or quite know, what is he talking about" as the understanding of what is hoped to be spoken of has yet to fully form. Polanyi states that such a situation might be described as cases of "fumbling" or "pioneering" (Ibid., p. 93).

Polanyi's ideas can be seen to have pertinent consequences for those wishing to adopt a third party, human-centred strategy when designing for live performance. However attentive and detailed a designer's engagement with a live performer or audience member might be, Polanyi's epistemology suggests that tacit knowledge might obstruct the understanding of subjects' practices during the design process. It is anticipated that tacit knowledge will be particularly prominent amongst the issues affecting individuals' lived and felt experiences of live performance, due to their subtle and complex nature. Therefore, it is argued that the ability of the human-centred designer to consider live performance holistically might be inherently limited.

The consideration of live performers' practices as evolving artistic endeavours, the understanding of which is emergent to the artist, further highlights the challenges faced by designers wishing to understand and respond to the experience of live performance from an external perspective. It might be argued that a live performer's knowledge of their practice and its experience will be shot through with tacit knowledge, which inhabits the domain of sophistication. That is to say, if the live performer cannot yet comprehend the evolving motivations and actions of their practice, it is unlikely that their knowledge of that practice will be easily articulated to a designer.

This final point might also have a significant bearing on the understanding of the autobiographical design strategy. As it can be seen, to Polanyi, knowledge is tacit for reasons that extend beyond the ineffable nature of particular concepts and ideas. Rather Polanyi's epistemology pre-supposes that we cannot recognise or be aware of everything we know, feel or experience, as there exist occasions where we have yet to fully make sense of particular aspects of our knowledge. It is anticipated that in cases where knowledge is tacit for such reasons, both the human-centred and autobiographical designer might struggle to understand experiences of live performance. Consequently, it is anticipated that tacit knowledge might not just pose challenges to those wishing to design for an external perspective. Rather, it might be a ubiquitous challenge of all strategies that hope to engage the subtle and complex issues of artists and audiences' experiences of live performance in design.

3.6 Reflection on the Design Strategies

The strategies reviewed in this chapter highlight the advantages and disadvantages of particular approaches to the design of interactive technology for live performance. The remediation strategy demonstrated how the consideration of previous interaction techniques and paradigms could allow for the proposal of interfaces that exploit live performers' existing practices in the context of technological possibilities (e.g. having a full recording studio on a laptop). However, the strategy's focus on replication was shown to conflict with the designer's ability to be innovative. Conversely, the examples of technology-inspired design illustrated how a focus on the particular characteristics and possibilities of novel technologies could inspire innovation in the design of interactive technologies for live performance. However, such an exclusive focus on technology was shown to lead to designs that overlooked, and in some cases conflicted with, the aspirations and experiences of the live performers and audiences that they were designed to serve.

Autobiographical design demonstrated how designers considering their own practices and experiences are able to propose innovative designs that are sensitive and responsive to issues underpinning the experience of live performance. However, concerns were raised about the practicality and

generalisability of an interaction design strategy that relies upon the designer's personal experience of a practice. The human-centred design strategy presented an alternative means through which issues of artists and audiences' experiences might be holistically engaged in design from an external perspective. However, the consideration of the strategy through the lens of Polanyi's (1958) epistemology of personal knowledge, raised concerns about an external designer's ability to comprehensively understand and engage others' experiences of live performances in design.

While discussed in isolation, it is clear that the strategies do not represent a discrete taxonomy of design approaches for live performance. Rather, it can be seen that significant overlaps between the strategies exist. For example, it is easy to imagine that a designer working for a software company that produces DJ tools, but also does some DJing in his spare time, might draw upon experience of his personal practice to introduce innovative features, while designing using a primarily remediation-based strategy. Alternatively, it is conceived that a designer partaking in one of the experience-centred design strategies surveyed (i.e. autobiographical and human-centred) may not consider their own, or others', experiences of live performance in isolation. Rather, a designer might draw upon the juxtaposition of the motivations, aspirations and experiences of their own or others' practices with, say, the possibilities of a novel technology to inspire and guide a design.

The discussion of the strategies illustrates the potential advantages and disadvantages of focusing interaction design on particular aspects of the relationship between live performance and interaction design (i.e. previous designs, technological possibilities or artists and audiences' experiences). It is argued that designers will be able to draw upon this discussion in order to configure (or reconfigure) their interaction design processes to occupy a position between the strategies that meets their particular design goals. In terms of the aims of this thesis, it is hypothesised that an appropriate design strategy might inhabit the space between autobiographical, human-centred and technology-inspired design. Recall, the research presented in this thesis seeks to develop, and propose novel and innovative designs in response to in-depth understandings of the experience of live performance. In the previous chapter, it was shown that live

performance is an activity defined in terms of subtle, complex and idiosyncratic issues, which are entangled with the lived and felt experiences of live performers and their audiences. The autobiographical and human-centred design strategies stand out as particularly advantageous approaches to address these kinds of subtle and complex issues of the live experience in design.

The examples of autobiographical design surveyed suggest that the designer's engagement with the experiences of live performance might be superior to that of the human-centred designer, due to the potentially tacit nature of live performers and audience members' knowledge of their practices. However, the external perspective of human-centred design might be a more suitable basis for interaction design that is applicable by a wide range of designers and might be more likely to produce generalisable and transferable designs. Therefore, it is argued that a suitable design strategy might seek to inhabit the middle ground between autobiographical and human-centred design, possibly by seeking to support the external designer in better engaging with tacit aspects of artists and audiences' knowledge and experiences. Finally, examples of novel technological possibilities inspiring innovative interaction design can be observed throughout the design strategies. Therefore, it is acknowledged that while not exclusively technology-inspired, any strategy that supports the novel and innovative design called for throughout this thesis should allow the designer to draw inspiration from the possibilities presented by emergent technologies.

3.7 Conclusion

In this chapter, a number of strategies employed previously in the design of interactive technologies for live performance have been identified and discussed. Discussion of these strategies highlighted the advantages and disadvantages of interaction design that emphasises particular aspects of live performance and its relationship with technology, such as prior functional designs. It is expected that the findings of this discussion will guide interaction designers looking to select, or reconfigure their existing, design processes to better address live performance.

With respect to the aims of this thesis, it was argued that a design strategy occupying a space between autobiographical, human-centred and technology-inspired design would best support both innovation and the holistic engagement

with artists and audiences' lived and felt experiences, identified as crucial to the design of interactive technologies for live performance (Section 2.7). Consequently, the understanding of interaction design strategies developed in this chapter informs the practice-led research conducted throughout the remainder of this thesis, by inspiring and guiding the strategies adopted in my own design practice.

CHAPTER 4

Exploring VJ Practice

4.1 Introduction

In Chapter 2, it was shown that artists and audiences' experiences of live performance are rooted in a number of subtle issues, which range from the transience of an individual performance to the sense of community that might arise at a live event. It was argued that due to the divergent ways these subtle and complex issues manifest themselves across individual live performance practices, interaction designers should not address these kinds of issues using abstract rationalisations alone. Rather, attention should be paid to the idiosyncratic relationship between issues of live performance and particular genres, practices, individual performers and audiences.

In Chapter 3, a number of strategies employed in the design of interactive technology for live performance were identified and discussed. These strategies revealed a number of advantages and disadvantages of focusing interaction design on particular aspects of live performance. The review suggested that a strategy situated between autobiographical, human-centred and technology-inspired design might best equip an externally situated interaction designer to propose innovative interactive technologies that engage and respond holistically to key issues of live performance, as they are lived and felt in particular artists and audiences' practices.

However, analysis of human-centred design through the lens of Polanyi's (1958; 1966) epistemology of personal knowledge, and its central notion of tacit knowledge, highlighted a particular challenge faced by those wishing to adopt such a design strategy. It was argued that the extent to which an externally positioned designer will be able to engage holistically with another person's practice, might be

limited by the ineffable and inarticulable nature of a subjects experiences of live performance. This challenge raises an interesting research question: how might interaction design be configured to allow interaction designers to engage with the complex, subtle and potentially tacit knowledge underpinning a live performer's knowledge and experience?

In this chapter, the early stages of a human-centred design approach (i.e. the development of an initial understanding of people's practices and experiences) are configured to allow the designer to engage more closely with the lived and felt experiences of live performance, with a particular focus on surfacing artists' tacit knowledge. The approach developed employs a series of activities, centred on a documentary film, that aim to inspire reflection amongst live performers about their personal practices. The approach is described and evaluated as it was applied to a group of VJs.

4.2 Surfacing Tacit Knowledge in Design

Tacit knowledge is ineffable; it arises in situations where the inadequacy of the relationship between our thoughts and our speech makes the articulation of what we know impossible (Polanyi, 1958, p. 87). Considering this fundamental quality of tacit knowledge, it might be argued that the externally positioned designer is destined to fail in attempts to engage tacit aspects of live performers' lived and felt experiences in design.

In this chapter, however, it is argued that by configuring a human-centred design approach in response to Schön's (1991) notion of "reflection-in-action", the tacit knowledge of live performers might be surfaced to provide insight for design. Like Polanyi, Schön rejected the primacy of abstraction and rationalisation in epistemology, arguing that "knowing is ordinarily tacit, implicit in our patterns of action and our feel for the stuff with which we are dealing" (Ibid., p. 49). Therefore, the description of knowledge in terms of rational schemas and theories alone was seen to neglect a particular form of tacit knowing-in-action essential to our everyday activities.

However, to Schön, the existence of tacit knowledge did not render the knowledge of a practitioner wholly inarticulable. Instead, the notion of reflection-in-action was proposed to describe the situation where a person is caused to

reflect upon, and hence potentially surface for articulation, knowledge that might normally be automatic or instrumental to their actions. This reflection-in-action – which often arises due to an interruption of an action, or other unexpected occurrence – might simply involve "noticing, at the very least, that you have been doing something right, and your feeling allows you to do that something again" (Ibid., p. 55). Alternatively, reflection-in-action might involve more conscious and purposeful thinking, through which a practitioner might "surface and criticise the tacit understandings that have grown up around the repetitive experiences of specialised practice" (Ibid., p. 61).

The prospect that occasions exist whereby a person is able to reflect upon ordinarily tacit knowledge, occurring in the activities of their practices, forms the basis of the key configuration of human-centred design presented in this chapter. It is hypothesised that if the externally positioned designer can employ approaches that stimulate their subjects to reflect upon the knowledge-in-action underpinning their practices, then, it might be possible to surface their tacit and personal knowledge for consideration in the design process.

4.3 Exploring Design for Live Performance amongst VJs

The design approach presented in this chapter was developed during a study of VJ practice. VJs are live performers whose practice involves the manipulation and presentation of visual media, such as video clips or computer-generated imagery, to audiences in settings ranging from nightclubs to art galleries. Arising alongside dance-club culture in the late 70s and early 80s, VJ practice has had a relatively short history in comparison to other performative art forms (Faulkner, 2006, p. 14). However, throughout this period the practice has rapidly evolved in line with emergent possibilities for the generation and manipulation of visual media (Taylor, et al., 2009).

Today, VJing is primarily conducted using software tools, which allow for the manipulation of high definition video-clips, or computer generated imagery, on a laptop computer. These laptop-based set-ups are often augmented with hardware control surfaces, which consist of buttons, knobs and sliders that are mapped to software functions. The most popular software tools for VJ practice include those highlighted in the discussion of the remediation design strategy in

Chapter 3, Modul8 (GarageCUBE, 2012) and Resolume (Resolume, 2012). Figure 15 shows a typical VJ set-up.

Figure 15: VJ set-up with a laptop computer and hardware control surfaces

VJ practice was selected as the subject of this study for primarily pragmatic reasons, to make the most of a burgeoning network of VJs that was forming around Newcastle University's interdisciplinary Culture Lab at the time of the study's commencement. However, VJing proved to be a particularly fruitful domain to study, as it presented the opportunity to uncover a novel perspective on the relationship between interaction design and live performance, which would add breadth to a discourse previously dominated by the consideration of electronic music performance.

A sample size of four VJs/VJ collectives was chosen. The choice to study a smaller number of participants reflected the approach's focus on developing in-depth and potentially subjective understandings of the participants' personal, and potentially tacit, knowledge of their practices. It was believed that attempts to broaden the sample size, without substantial increases in the period of study, would have reduced the detail of study and closeness of engagement with participants' practices.

4.4 Documentary Film

The approach employed in this study of VJ practice was centred on a documentary film that addressed each of the participants' creative practices. The choice to create a documentary film was initially motivated by the desire to capture an in-depth and realistic account of the VJs' practices, which would be used as a valuable resource when seeking to develop an understanding of the subtle, complex and potentially tacit issues that would affect the design of interfaces for the domain. However, as the filmmaking process commenced, it became clear that the medium of documentary film offered a range of advantageous qualities that could be used as the basis of activities that would inspire reflection amongst the VJs about their personal practices and, therefore, assist in the surfacing of their tacit knowledge. In this way, the approach developed builds upon previous uses of documentary film in the design process as a means to uncover in-depth and holistic insight into people's practices and relationships with designs (e.g. Gaver, 2007; Raijmakers, Gaver and Bishay, 2006), by employing film as the basis for a reflective dialogue between researchers and participants.

A professional filmmaker and I produced the film. The participants were observed and filmed as they prepared, practised and performed their work during the course of a month long audio-visual arts festival, which was held in the north east of England. The film had a total duration of approximately 12 minutes and comprised of four vignettes (on average three minutes in length), which each addressed one of the participants' practices.

4.4.1 The Filmmaking Process

The choice to base the design approach upon a documentary film was made for a number of reasons, which related to both the filmmaking process and the film produced. Firstly, it was hoped that by making a film we would be afforded the opportunity to follow the VJs closely as they prepared for and performed their practices. Therefore, it was expected that the process of making the film would provide an initial understanding of the participants' practices, which would be built upon throughout the remainder of the approach. Furthermore, by permitting observation of the participants' practices directly, in context, it was expected that

the process of filmmaking would assist the development of understandings of particular issues or qualities that might have proved challenging for the participants to articulate if we had sought to address them during, say, a verbal interview alone. The process of editing the film was also anticipated to assist in our understanding of the participants' practices. It was projected that as the footage was meticulously reviewed and edited, to illustrate and evidence our initial assertions through the selection and cutting of clips, the filmmaker and I would be challenged to reflect upon, and hence further develop, our understanding of the participants' practices.

In these ways, it was intended that our involvement in the filmmaking process would inspire the filmmaker and me to reflect upon and refine our understanding and interpretation of the field setting. It is argued that the use of filmmaking, as well as the resulting film, as a means to support the researchers in reflecting upon the practices of the VJs differentiates the approach from Gaver's (2007) Cultural Commentators, where documentary films were created without the researchers' direct involvement.

4.4.2 The Film

When analysing the intricate concepts that were expected to be encountered amongst the potentially tacit qualities of the participants' practices, it was resolved that the understandings developed by the filmmaker and me would prove to be highly subjective. However, unlike previous work that has viewed subjectivity as a weakness of using film in the design process (Mackay, 1995), the personal nature of the understanding that would be conveyed through the film was seen as an opportunity to inspire reflection amongst the participants, by pushing them to respond to assertions made in the film that might not tally with their own accounts of their practices.

Schön (1993, p. 55) argues that reflection-in-action is often spurred by surprise or the interruption of a person's normally automatic or instrumental actions. By presenting the participants with a subjective portrayal of their practices, the filmmaker and I hoped to interrupt common assertions that they might make about what they do as VJs. Therefore, it was hoped that the film would inspire participants to reflect upon, and hence surface in the discussion, knowledge

that might normally be taken for granted. Moreover, the third party perspective of the VJs' work given by the film, was expected to reinforce aspects of their personal conceptualisation of their own practices, which might not be fully formed due to reasons relating to Polanyi's (1958, p. 93) "domain of sophistication"; therefore, further aiding articulation.

To bring forth reflection-in-action amongst live performers after the moment of performance might seem like an ill-fated endeavour, as the actions of VJ's during the live show will have long passed. However, it is argued that the action of interest in our participants' practices will not be found on the stage alone, but rather in the VJ's ongoing and ever developing participation in their artistic practice. Schön (1993, p. 62) referred to such prolonged action in practice with the notion of the "action-present": the potentially extended "zone of time in which action can still make a difference to the situation".

Film was chosen as the means to stimulate reflection-in-action, and elicit the participants' responses, for a number of reasons. Firstly, film has been reported to capture and portray the "elusive details" of situations (Brun-Cottan and Wall, 1995) that other methods of presentation, such as a verbal or textual description, may miss. As such, it was expected that film would communicate our interpretations in the detailed context of the practice from which they arose. Moreover, film has been reported to place the viewer in a situation from which they may witness the reality perceived by the filmmaker (Raijmakers, 2007). Therefore, by presenting the interpretation of the participants' practices using film, it was hoped that the participants would be given the opportunity to observe their practices from the filmmaker's and my point of view.

To reinforce this strategy, a montage style was adopted in the editing of the film, where interview footage was juxtaposed with relevant scenes of the subjects at work or in performance. Hence, it was hoped that a film would be created that portrayed our interpretation of the performer as a reality or truth that was depicted with their words and actions alone; consequently, evoking a much stronger response, than if the ideas represented had been actively spoken by the filmmaker and me as an additional narration track.

In the following sections, each of the featured performances is introduced, alongside a description of the interpretation that the film sought to convey. As VJ

practice is both public facing and personally significant, with their explicit permission, the participants' real names are used in the description, analysis and discussion presented in this chapter.

4.4.2.1 3D Disco

The 3D Disco was a performance that took place in a nightclub setting. A collective of VJs produced the piece; two of whom (Andrew and Elliot) took part in the study. A 3D Disco performance consisted of 3D images that were projected around a venue; audience members would wear special glasses in order to see an anaglyph 3D effect. The visual materials of the 3D Disco were created prior to the performance in the VJs' studio using the motion graphics software After Effects (Adobe, 2013). These visuals were then divided up into short clips that were triggered live in a semi-scripted sequence together with a soundtrack using the commercial VJ software Modul8 (GarageCUBE, 2012). The visuals consisted of animated images of well-known musicians, figures and characters from the 1980s, while the soundtrack included remixes of popular music from the same era (e.g. Kate Bush's "Running Up That Hill") created by a member of the collective.

The collective that produced the 3D Disco had many years of experience of VJ practice and were able to earn a living from VJing and other digital media practices (e.g. creating motion graphics). However, at the time of the study, the 3D Disco was in its early stages of development and the performance included in the documentary was one of the initial showcases of the piece. In the years following our study, the 3D Disco has proven to be a very successful performance for the collective, which has been shown in high profile venues all over the world. Figure 16 shows an audience member silhouetted against a screen during the 3D Disco section of the documentary.

The 3D Disco vignette emphasised the relationship between audience enjoyment and the theme and content of the performance. The film sought to stress how the technical challenges posed by the presentation of 3D visuals limited the VJs' ability to manipulate visuals live and, therefore, the extent to which the performers could improvise and experiment during the moment of performance. This discussion was contrasted with footage of audience members revelling in the atmosphere of the event and an interview of the VJ just after leaving the stage,

where he recalled his enjoyment and satisfaction with the performance. Consequently, the film attempted to question whether the audience's experience of a live performance is actually affected negatively because of the reduced scope for improvisation and experimentation imposed by the pre-rendered visuals.

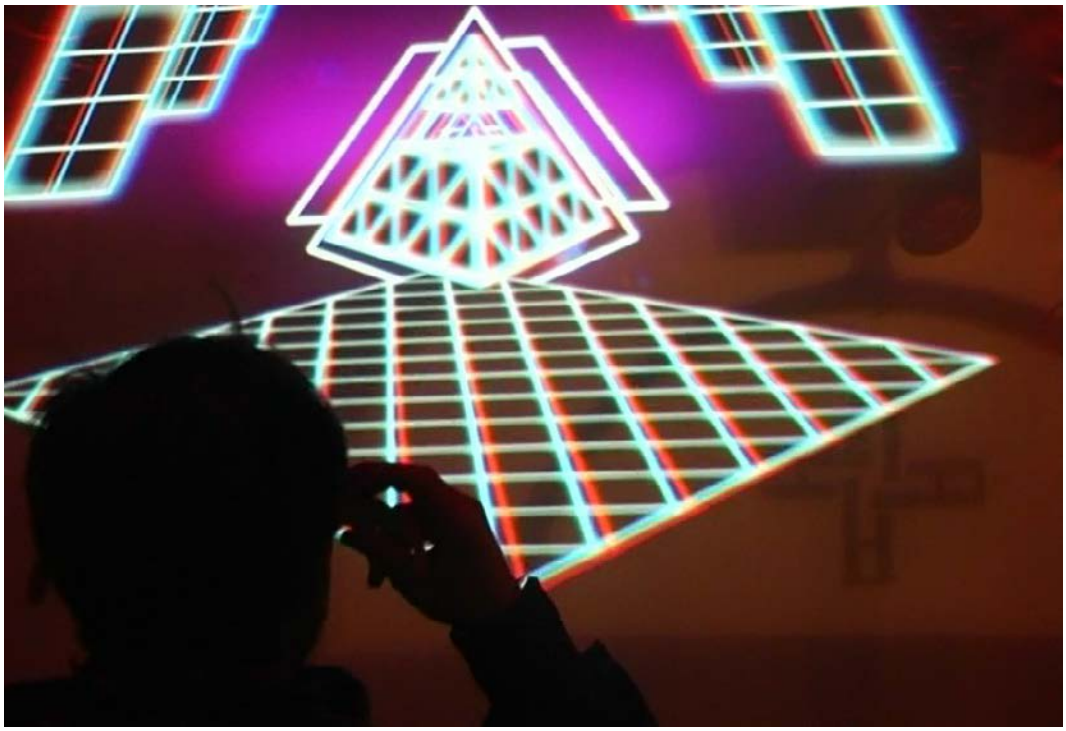

Figure 16: An audience member at a 3D Disco performance

4.4.2.2 Electro-Flamenko

Electro-Flamenko was a band that fused the sounds and styles of traditional Flamenco with electronic music. The band consisted of musicians, singers, dancers and a VJ (Alasdair), who was the primary subject of the vignette. Alasdair performed on stage alongside the other members of the band, manipulating video clips using a hardware controller and the commercial VJ software Resolume (Resolume, 2012). The resulting visuals were then projected at the rear of the stage, such that the other band members silhouetted them. Alasdair's visuals comprised a selection of both *found footage* of old movies, many of which included scenes of Flamenco dancing, and footage that he had captured himself during the band's recent tour of Spain. During performance, Alasdair would cut, loop and apply colourful visual effects to these images in synchrony with the rhythm of the musicians' performance. At the time of the study, Alasdair was a Master's student

and his work with Electro-Flamenko was conducted as part of his studies and in his spare time. Electro-Flamenko can be seen in Figure 17.

The Electro-Flamenko vignette highlighted the extent to which Alasdair's visuals were intertwined with, and hence less meaningful without, the other visual and sonic elements of the band. Footage of the different elements of the band was shown alongside interview footage of Alasdair speaking about his idea of a complete audio-visual artwork and the importance he places upon links between image and sound. The vignette sought to bring to light Alasdair's requirement for an interface that allows for powerful manipulation of visual material, while remaining portable enough to accompany him on tour. As such, the vignette tried to enquire as to whether an interface for Alasdair's VJ practice must be complex and bespoke in order to be expressive, or if something simpler would be more fitting.

Figure 17: Electro-Flamenko during a performance

4.4.2.3 Kinetxt

Kinetxt was an interactive visual performance, created by two VJs (Toby and Andrew), which was held in venues ranging from galleries to nightclubs. Audience members entered passages of text using computer terminals, which were situated around the performance space. Using a Nintendo Wii controller, the performer then created a narrative from these passages, which was displayed on a large

panoramic screen at the front of the performance space. In addition, a graffiti artist whose sketchpad was projected behind the passages illustrated this narrative. The audience responded to this evolving narrative by entering further passages of text; as such, a dialogue developed between the performer, graffiti artist and the audience. Figure 18 shows a Kinetxt performance.

Figure 18: The graffiti artist and panoramic screen during a Kinetxt performance

The Kinetxt performance was made possible by a technical infrastructure created by Toby, which used the server-side scripting language PHP to facilitate communications between the computer terminals and the visual programming environment Quartz Composer (Apple, 2013) to combine the passages of text entered, the video stream of the artist's sketchpad and the performer's interactions with the Wii controller into the visuals displayed on the large panoramic screen. Andrew and Toby were professional VJs and the Kinetxt performance was created for, and funded by, the digital arts festival that the performance was featured in. However, since the study Kinetxt has been shown on many occasions and in many different venues.

By showing a collage of the elements of Kinetxt from the perspective of an audience member, the vignette sought to stress how the performance surrounds

and immerses the viewer. Footage of Toby giving an in-depth walkthrough of the technical infrastructure behind the performance was shown in order to expose the role technology played in creating an environment conducive to a particular experience of immersion in a dialogue, as opposed to being a tool of manipulation or presentation like in the other vignettes.

Figure 19: John, of Tron Lennon, surrounded by his equipment

4.4.2.4 Tron Lennon

Tron Lennon was an audio-visual collaborative performance created by two improvisational electro-acoustic musicians (John and Paul), who described their VJ performances as an experiment into the inclusion of visuals into an exclusively musical practice. Paul had a background as a turntablist while John had a background as a guitarist. In their visual practice, John and Paul extended the capabilities of their musical instruments in order to improvise with video material. Paul used the MsPinky (MsPinky, 2012) digital vinyl system to scrub through video clips using a turntable, while John augmented his guitar with a range of camera feeds, which were manipulated in response to his guitar and effects units. At the time of the study, John and Paul were both studying for PhDs in music and their performances as Tron Lennon were conducted as part of this research. At the time

of the film's production, John and Paul were in the process of preparing for a residency at STEIM, the Studio for Electro-Instrumental Music in Amsterdam. Figure 19 shows John surrounded by his equipment.

The vignette emphasised the contrast between the practices of John and Paul and as such sought to stress that rather than co-creators of a single practice, they are two performers with well-defined practices of their own in collaboration. Interview footage of Paul speaking almost exclusively about his desire for finite control and powerful manipulation of video content was set next to John's discussion of the adaptation and misappropriation of technology. Footage of Paul and John's visuals were shown in isolation to illustrate the contrasting aesthetics that were combined to produce the final visual output. Through the isolation and juxtaposition of aspects of both practices, it was hoped that the film would enquire about the reasoning for, and consequences of, collaboration between such differing performers.

4.5 Dialogical Exchange

Discussing video footage of people's practices with them has been shown to provide a valuable mechanism to refine understandings developed during user studies (Brun-Cottan and Wall, 1995; Buur, Binder and Brandt, 2000). In the next stage of the approach, the participants were given the opportunity to enter into such a conversation about their own, and the other VJs', portrayal in the film, during a focus group. The filmmaker, the VJs featured in the film and I attended this focus group. During the focus group, each of the vignettes was shown in turn, followed by a group discussion. It was intended that the topics of discussion were to be primarily guided by the participants in reaction to the film. However, at times the filmmaker and I took a more active role in the discussion, asking for comment on particular aspects of each vignette that we had considered to be of particular importance.

Figure 20: The participants watching the film during the focus group

The principal aim of the focus group was to elicit further insight by scaffolding reflection upon the participants' practices during a critical dialogue about the film. As a method of engaging with users, focus groups were seen as a highly appropriate means of fostering such reflection. Discussion of a topic during a focus group has been reported to allow participants to explore and clarify their ideas and, therefore, advance and change them in response to the views and experiences of others (Kitzinger, 1994). Therefore, it was anticipated that the participants would be provoked to reflect on issues of their practice as they were discussed from alternative perspectives and depicted in the practices of others. Furthermore, focus groups have been reported to give participants a better opportunity to control how topics are addressed by "generating their own questions and pursuing their own priorities" (Kitzinger, 1995). As a result, it was expected that the participants would use their expert knowledge of VJing to guide discussion toward the most pertinent issues raised in the film and to broach additional issues that the filmmaker and I might have not paid attention to during the filmmaking process.

As a method for affording engagement with personal and tacit aspects of live performers' practices, focus groups were seen to be potentially limited in one

important respect. Focus groups have been reported to stifle the opinions of individual participants, in favour of views held more widely in a group (Kitzinger, 1994). As such, it was anticipated that gathering a spectrum of opinions on an issue, and differentiating the views of individuals from those enforced by the group, might prove problematic. This dilemma was thought to be particularly relevant in the context of live performance, where a homogenised group opinion may not capture the participants' personal knowledge of their practices, which the approach hoped to reveal. Consequently, a semi-structured interview was conducted with each of the participants following the focus group, which lasted approximately 20 minutes. By conducting these interviews after the focus group, it was possible to address topics that emerged during the discussion. As a result, it was hoped that those issues considered important by the group would be examined from the perspective of each participant's individual practice.

4.6 Creative Response

The final phase of the approach involved a novel Creative Response activity. The activity made use of the participants' standing as creative practitioners, by asking them to create a short re-edit of our documentary film that emphasized their response to a particular issue (or range of issues) that had been raised by our film or during the focus group. Participants were provided with the raw footage that the filmmaker and I used to create the film and digital video editing equipment with which to edit it. The participants were then given a period of around two hours to produce their response, which they were asked to make approximately 2-3 minutes in length. On completion, its creator(s) presented each response to the other participants, the filmmaker and me. The presentation of each response was coupled with a short verbal rationale explaining its content.

It was envisaged that there would exist elements of the participants' personal knowledge that were so intertwined with a practice that reflection on them, and their articulation, outside of its context would prove particularly challenging. Hence, it was predicted that the retrospective discussion of the focus groups, even when augmented with the reflective tool of the documentary film, might not be sensitive to particular aspects of the participants' practices. The Creative Response activity was designed to respond to this challenge by utilising

the creative act of filmmaking, this time by the participants themselves, to afford both contextual communication and reflection.

Firstly, the Creative Response activity sought to utilise film as a language through which the participants could incorporate elements of their practice directly into the discussion of an issue. It was expected that, by selecting and editing particular clips, the VJs would be able to demonstrate concepts bound in tacit knowledge, which might have proved difficult to articulate during the earlier stages of the approach. It was hoped that by allowing the participants to more directly incorporate aspects of their actual practices and actions into the discussion in this way, they might be assisted with the articulation of potentially otherwise ineffable knowledge.

It was expected that giving the participants the opportunity to illustrate points made in the earlier focus group would assist them in articulating each of the three forms of tacit knowledge set out by Polanyi (1958, p.93). In the case of ineffable aspects of their practices, or ineffable relations between those that are easily articulated, these might be surfaced through demonstration. While in the case of the domain of sophistication, participants might be empowered to bring forth elements that remain elusive to themselves for discussion, and consequential clarification, with the other participants through its inclusion in the response.

The creative process of making a short film was also chosen as a means to push the participants to reflect about their practices in a detailed and methodical manner. It was expected that as footage was edited to respond to individual issues, the participants would be stimulated to examine, and reflect upon, the account they hoped to convey in the detailed context of the practice from which it arises. It was anticipated that this activity would inspire the participants to further question the assertions underpinning their personal conceptualisations of their practices; thus, inspiring further reflection-in-action. As the Creative Response activity would be approached by the VJs with the ideas raised by our film and the focus group in mind, it was anticipated that the participants would be inspired to cross-examine their practices from these novel perspectives, and feed insights from this further reflection into their responses.

Previous work has explored how involving users in the filmmaking process can inspire reflection (Buur, Binder and Brandt, 2000). However, this involvement

was limited to consultations about the content and topic of a film, similar to that conducted in the dialogical exchange phase of the approach reported here. The Creative response activity extends this previous work by leveraging the technical and creative abilities of the VJs to incorporate the involved activity of re-editing a film into attempts to inspire reflection on their individual practices.

4.7 Analysing the Participants' Response to the Film

The analysis of the findings from this application of the approach is presented in two parts. Firstly, the discussion during the focus groups is analysed, followed by further insight gained from the participants' Creative Responses. While these elements of the findings are presented separately, it should be stressed that my presence and participation during the filmmaking process, focus group and the Creative Response activity, led to an underlying personal understanding of the participants' practices that affected the interpretations discussed throughout both these analyses. Therefore, the findings presented should be considered a product of the whole process, rather than as the sole product of any particular activity (i.e. the focus group or the Creative Response).

To assist in the understanding of the discussions held during the Dialogical Exchange phase, a thematic analysis was conducted according to guidelines set out by Braun and Clarke (2006). The focus group and subsequent interview sessions produced a combined data set consisting of approximately 4 hours of video footage. After transcription, this data was first open coded to highlight potential trends in the participants' discussion of their practices. Following this, an iterative process was completed whereby the initial trends were grouped into categories and these refined. An inductive rather than a theoretical thematic analysis was followed and therefore any pre-determined theoretical frameworks or hypotheses were not used to explicitly guide the coding and categorisation process. The themes developed are discussed in the following sections.

4.7.1 Aspirational

The first key superordinate theme that arose in the data related to the differing aspirations, desires and intentions that shaped each of the participants' practices. Such conceptual aspirations were seen to inspire all aspects of the participants'

work; from the motivation that determines the subject and composition of a piece, to decisions and actions made during the moment of performance. In this way, the theme aspirational highlights a particularly pertinent concern for those designing for live performance, the artistic aspirations and motivations of performers.

4.7.1.1 Meaningful

Significant weight was attributed to the existence of meaning in a VJ's performance. Alasdair, for example, described how a central aspect of his performance was the creation of novel meaning through the re-contextualisation of found film footage, which he hopes to communicate to the audience during a show. Toby suggested that the desire for a meaningful performance is something that develops in a VJ's practice over time. He recounted a rite of passage whereby the VJ begins to explore the creation of a performance that extends beyond being more than "pretty pictures", to contain some deeper conceptual significance.

> *"After a while you go: 'I am happy controlling this screen for X hours, pretty pictures whatever that I do that I am happy with' and then you kind of go 'ahhhh so what's next?' There are a few different avenues to go down and for me narrative is the most interesting." (Toby)*

As highlighted above, the predominant form of meaning discussed was narrative. This might be expected, considering the dominance of narrative in related video-based art forms, such as film or television. However, the participants exhibited resistance against the inclusion of traditional prescribed linear narratives in VJ performance. Instead, the participants spoke of wishing to explore how the liveness of VJ practice might afford novel ways of telling stories using visual media. For example, Andrew wished to explore the "random" nature of a live show to create something that differed from a film, while Paul spoke of his intention to disrupt the traditional presentation of narrative.

> *"The really strong theme that's running throughout this is trying to create some narrative in what you are doing; whereas a lot of the stuff I'm actively trying to do is actually trying to fracture narrative as well, and that's where the needle dropping thing comes from." (Paul)*

The participants' desire to imbue their performances with particular meanings highlights expression as a crucial experiential quality of live performance, missing from the dimensions identified in Chapter 2. Therefore, the findings suggest that those designing interactive technology for VJs might benefit from asking how their designs might assist live performers with the investment of meaning in, and its subsequent expression during and through, their performances, rather than simply supporting the technical display and manipulation of visual media alone.

4.7.1.2 Evocative

Andrew and Toby exhibited a desire to evoke particular experiences amongst the audiences of their performances. In the case of the 3D Disco, Andrew explained how the anaglyph visuals were designed to stir up feelings of astonishment and amazement amongst the audience, as they protruded from the screen. Toby spoke about how Privy (an additional performance mentioned in comparison to those featured in the film) was designed to create an emotional experience for those witnessing it.

> *"Privy is kind of this very kind of dream-like thing where if you sit back and let it wash over you. It is a very emotional experience." (Toby)*

In other extracts, Andrew described how he aimed to afford audience members an experience of immersion in a situation, by utilising audience participation to tailor visual content to the environment of performance. He also spoke of how intentionally ambiguous materials were used at times in order to provoke curiosity and inquiry amongst audience members.

> *"A bit of footage will be very blurred and you will just get a sense of what's happening and it's all about building up your own sort of thoughts about what's happening or what the story is about." (Andrew)*

The aspiration to evoke an emotional response amongst audience members reiterates the importance of expression as a quality of the VJs' practices. However, the participants' desire to evoke a meaningful response, suggests that those designing for VJ practice might benefit from considering expression as more than a communicative phenomenon (as suggested in the previous section), but rather a

process whereby the performer leads their audience to develop their own personal meaning while they experience a performance. Additionally, Andrew's discussion of dialogue amongst performers and audience members, as part of the stimulation or evocation of an emotional response, suggests the existence of a relationship between the potential connection, or sense of community, experienced by those sharing in a co-located live performance and the potential for the investment and expression of meaning through a VJ performance.

4.7.1.3 Evolving

The drive to evolve and develop their practices was seen as essential to many of the participants. Andrew spoke of the enjoyment he experienced when trying out new possibilities and, conversely, described how something as simple as boredom could compel the VJ to push their work forward in new and explorative directions.

> *"The most enjoyable aspect of it is to create new things. It's all about creating new pieces of work, or new elements [...] it's very easy to get bored by a lot of stuff, so it's keeping fresh and keeping new." (Andrew)*

New technological possibilities arose as a particularly prominent driver of evolution in the participants' practices. For example, Elliot described how the exploration of new types of sound-reactive visuals was a major source of inspiration in his practice at the time of the study.

> *"Oh yeah, I am completely technology driven, I love reactive visuals and I am trying to develop that further." (Elliot)*

These findings suggest that a VJ's performance is much more than a conduit for emotional expression. Rather, each VJ's practice would appear to be more akin to a personal possession, or even companion, which is nurtured and evolved over time in response to the performer's aspirations. In the case of some of the participants, the exploration of new directions and ideas in this way, often inspired by novel technological possibilities, seemed to be a crucial factor motivating their participation in VJ practice. Therefore, it is suggested that it might prove beneficial for those designing interactive systems for VJs to not only consider the current state of a performer's practice when designing, but also how design might support its ongoing development and evolution.

4.7.1.4 Pride-worthy

A sense of pride felt in one's own work arose as an important motivating factor for the participants, which pushed them to produce high quality performances even in situations where a mediocre effort might satisfy the audience, or promoter, of a show. For example, Elliot described how, when doing performances at commercial club-nights, despite being able to do just enough to be paid, he always tries to perform at the highest standard.

> *"You can turn up and be really blasé about it, and just be there just to get a bit of pocket money, but sometimes you really want to be there because the people are watching what you're doing, and your name is on a list on the line-up, and you want people to look at your work and say, 'Hey actually he's quite good!'" (Elliot)*

The fear of making mistakes, and as a result degrading the audience's experience of a show, was also a key issue. For example, Andrew described how the successful elements of a performance might go unnoticed while the simplest of mistakes could be markedly jarring to the audience and, therefore, have a seriously detrimental effect upon their enjoyment of an event.

The evident sense of pride felt by the participants in their practices, and the resultant pressure to perform well, further demonstrates the strong personal relationship felt between a VJ and their practice. When this theme is considered in combination with the VJ's desire to evolve their work, a practice arises to not only be something the VJ does, but rather something they have greatly invested in and as such will cherish and nurture over time. Hence, a challenging design question is posed: how might a design support, or simply relate to, this personal relationship between performer and practice, which has arisen to be so crucial to the participants' experience of VJing?

4.7.2 Interaction

A second and particularly dominant superordinate theme in the discussion was the relationship between particular qualities of interactive technology and the participants' practices. Each of the following themes addresses a particular quality of technology and the effect that it had on the participants' practices. By exposing the association between the qualities of existing interactive technologies and

various experiences of VJ practice, it is expected that these themes will provide valuable insight and guidance for those designing future interactive systems for VJs, and potentially those in related domains of live performance such as electronic music.

4.7.2.1 Constraining Interaction

The constraints of technology arose as a particularly prominent topic of discussion. Interestingly, rather than being viewed in wholly negative terms, technological constraints were often considered to make a valuable contribution in two key ways. Firstly, the participants reported that the possibilities posed by novel technology would often overwhelm them as performers. As such, technologies that were limited in certain respects (e.g. by lacking in particular features) were praised as a means by which the VJ was able to focus upon the creation of a particular performance, despite the infinite possible permutations of visual media, which they might create.

> *"Working in tight knit spaces is really useful, just exploring one small area. I'm never going to explore all of the possible areas but at least I might get somewhere with something." (John)*

Secondly, constraints were praised for their function as a mechanism for creativity. For example, in one of Elliot's performances based upon the manipulation of nothing but a white cube, the simplicity of the manipulations afforded was said to inspire, rather than limit, ideation.

> *"I manipulate a white cube on the fly […] every set it's entirely different, with the same sort of feeling but you know it, you are constantly coming up with new ideas all of the time, because you are just working with one white cube." (Elliot)*

The notion of constraint as a means of inspiration arises as an interesting avenue for exploration by those designing interactive technologies for VJs. Parallels can be drawn between these findings and McCullough's (1998, p. 194) notion of the digital craftsperson's medium. To McCullough, a medium is the range of possibilities presented to a craftsperson, by the combination of their materials and tools. However, a medium is said to be much more than a blank canvas to receive a craftsperson's intent. Rather, it is a "locus" for the application of the skills

and ideas, which by responding and resisting action invites the craftsperson into a dialogical and creative exchange.

Constrains are central to McCullough's definition of a medium, as without constraint no one medium would have a character or present a particular response or resistance (Ibid., p. 200). Therefore, when considered with regard to the ideas of McCullough, the constraints of technology mentioned by the participants might be considered as definitive characteristics of the VJ's medium. Consequently, a design stance is suggested, where interactive technologies are not simply proposed as tools that allow for the completion of specific actions of a performance, but rather as media, or materials, which are dialogically moulded and crafted as part of the ongoing development of a VJ's practice.

4.7.2.2 Haptically Direct

Participants spoke of wanting to "get hold of" and "grapple with" media during performance. The use of such descriptive terms implies a desire for interaction that provides a sense of being in direct contact, or touching and moulding the underlying technology or media of a performance, as if it were an artefact in the physical world. However, existing VJ tools that afforded such direct manipulation of media were said to be rare. Toby, for example, noted how the mode of interaction afforded by the controller he uses is disconnected from the video media that it allows him to manipulate.

> *"I want something [so] that I can directly grapple with the media that I'm dealing with. At the moment I have a planar flight deck of buttons and knobs and that has got nothing to do with video flowing in real time." (Toby)*

Paul gave an example of a device that did afford such haptically direct interaction. He described how the turntable, when equipped with a digital vinyl system to control video files, gave him a sense of touching and feeling the sound in the videos manipulates. However, the sense of directness and intimate interaction was said to be experienced to a much greater degree with the audio component of video than the visual. In a later excerpt, this was attributed to the comparatively low sample rate of the media's visual component.

"I've got this really gestural interface that is a turntable I can really feel the sound in the video, whereas if you've got something that's plastic, costs about 80 quid and you are trying to, I dunno. You don't get the same kind of feel, experience, interaction." (Paul)

Parallels can be drawn between this desired form of interaction and the manipulation of acoustic musical instruments, described throughout many of the examples of autobiographical design discussed in Chapter 3. Discussion of acoustic instruments praised the direct physical relationship between the performer's gestures and the sound produced by the instrument. This kind of relationship was said to allow the performer to enter into an intimate and dialogical relationship with their instrument, which pivots around the ability to feel the instruments responses to particular interactions. Returning to McCullough's (1998, p. 194) notion of a medium, the participants' desire to directly "grapple" with the media of their performances might, therefore, be interpreted as a desire to engage directly with the qualities of the medium of their practice, which existing designs might limit through the gulf between the form of interface and underlying media.

4.7.2.3 Immediacy

A temporally immediate response to an interaction was considered essential to many of the participants, when manipulating media during live performance. Paul, for example, spoke of plans to move away from the digital vinyl system he used to control video, due to the unacceptable latency it introduces.

"The latency, well it's not ideal especially for scratching so I'm trying to move away from time-coded vinyl." (Paul)

Immediacy was also discussed in terms of predictable and modeless interaction. Andrew described how hardware control surfaces presented a consistent one to one mapping of control. As a result, such devices were said to allow desired functionality to be immediately found and utilised during the stress and pressure of a performance. Generic control devices, such as the mouse, were not seen to afford such immediacy, due to their varying mapping between physical form and function.

"With a mouse and pad, you can do a million things with it but you've got, it changes each time; but you know you can hit a key, or hit the Kaos pad like that, you know what you are going to do straight away and it's immediate." (Andrew)

The participants' call for immediate interaction also relates strongly to the desire for haptically direct interaction highlighted in the previous theme. However, the comments suggest that designers might consider the notion of a direct and intimate relationship between the performer and their instrument, or medium, in terms of more abstract qualities such as latency or the predictability of a response to interaction.

4.7.2.4 Manipulable Media

A desire for tools and controllers that afford powerful and varied manipulation of media during the moment of performance was evident in the participants' comments. Toby, for example, stated that when performing he desired as much control as possible.

"The key thing is, giving yourself the maximum potential for effecting and controlling what you want to do." (Toby)

Participants showed frustration with the use of pre-rendered media in their performances (i.e. media that is created prior to performance). Pre-rendered media was utilised in the participants' performances for reasons including technical constraints (e.g. a laptop not having sufficient processing power to render a visual live) or the avoidance of tasks that are too complex or time-consuming to be practically completed in real-time during performance.

Despite these advantages, the participants showed frustration with the use of pre-rendered media due to its immutable nature, which would restrict their ability to manipulate visuals live during performance. The prominence of such comments illustrated the participants' desire for materials that could have substantial manipulations made to them during performance, as opposed to immutable materials that can only be collaged and have effects applied.

The participants imagined devices analogous to audio-synthesisers for visual media as a possible solution to this challenge. Such devices were envisioned as having the potential to allow new content to be generated, on the fly, during a

live performance; therefore, allowing the performer to break away from the restricted manipulation associated with rendered sequences of video clips. Whilst video synthesisers have existed since the late 1960s (e.g. the Spectre Colour Video Synthesizer), the participants did not seem satisfied with the quality or form of the visuals that existing systems produced.

> *"We need something like synthesisers, you know electronic synths. When synths came through, like drum machines and things, you were creating things on the fly; you were creating things from nothing really." (Andrew)*

The views expressed in this theme highlight a particularly pertinent question for designers of VJ software. How can interactive systems be developed that afford performances of high quality visual media, without restricting the performer's ability to manipulate that media during the moment of performance. Furthermore, it is argued that these findings represent a further component of the evident desire amongst the participants for direct and unrestricted interaction with the technology and visual media of their practices.

4.7.2.5 Visible Interaction

A number of the participants expressed a desire for interfaces or controllers that would make the performer's interaction visible to the audience. Alasdair described how controllers that let the audience see his interactions during performance were essential to his practice, even if that visibility did not equate to an understanding of his actions by audience members.

> *"If you are on stage they will see you doing something; you know they will see you playing a keyboard or interacting with an interface or whatever. Whether they understand that what you are doing is live visuals, in the context of a band I mean, I guess that doesn't really matter, as long as they are seeing you on stage performing, and they get a sense that something special is happening" (Alasdair)*

Toby's views extended beyond those of Alasdair, as he wished that the audience might not only see what he was doing, but also gain insight, and hence an in-depth connection with, the thought processes and motivations that underpin his actions. In this respect, he envisioned a future performance technology that would externalise the decision process that guided a performance.

"If we had an interface that was, that really was transparent to the audience, in the sense that your actions, your decision process, everything like that is as obvious to the audience as it is to you as you kind of go through it; then absolutely you have a very compelling reason to be on the stage." (Toby)

Strong parallels can be drawn between the participants' desire for interactive technologies that offer visible interaction and the notion of presence in a live performance identified in Chapter 2. Consequently, supporting the performer's established presence in the performance environment is highlighted as a crucial concern for designers of interactive systems for VJs. Moreover, the findings stress the importance of visibility, and in some cases legibility, of the performer's interactions to the design of interactive technologies that seek to support or enhance presence in VJ practice.

4.7.3 Live

The final thematic category relates to the particular qualities that the participants associated with the status of VJing as a live performance. By situating the presentation of visual media in a live context, the participants' practices were described as having a range of values, which set the act of VJing apart from other forms of visual media (e.g. film).

4.7.3.1 Improvisational

A central quality arising from the liveness of VJ practice noted by the participants was the opportunity to imbue the creation and manipulation of visual media with aspects of spontaneous improvisation. Participants described improvisation in wholly positive terms, associating it with satisfaction, interest, play and artistic freedom.

"There are lots of opportunities to be quite improvisational, which is a good thing because it's quite satisfying and gives you a sense of artistic freedom" (Alasdair)

Digging deeper, improvisation appeared to be more than a satisfying and interesting trait of a practice, but rather a mechanism by which a performer creatively explores the relationship between aspirations and materials in ways that might not be possible outside of the moment of performance. Toby spoke of

how the act of experimentation during a live performance would inspire ideas, which would have a bearing on their practices in the long term.

> *"So with my live cinema piece, which is basically an hour long, say, I basically performed that for about eight hours straight, and tried every combination with everything else, with all these different things, you know, and discovered a thousand things that I never would have come across if I was a film-maker." (Toby)*

These findings illustrate the importance of improvisation as a quality of the participants' experiences of live performance. Therefore, the support of an improvisational performance is put forth as a crucial consideration for design. It is expected that the earlier theme manipulable media might prove decisive in attempts to design for such improvisation, as the act of improvising may prove to be a challenge without the ability to manipulate visual media live.

Furthermore, an interesting dynamic of improvisation is raised, where the act of participating in live improvisation leads to the development of a practice, which would have not been possible out of this context. Here, parallels might be drawn the notions of knowledge-in-action, which underpin the approach presented in this chapter, as the findings suggest that the VJ possesses a particular knowledge or ability to develop ideas while participating in the act of improvisation, which they do not possess when, say, working in the studio.

4.7.3.2 Responsive

Participants described how performing live allowed them to incorporate a range of stimuli from the environment into their practices. These included the music played by a DJ, live camera feeds and active participation from the audience. The notion of a responsive performance was of particular importance to Elliot, who described how the incorporation of the environment into his performance is the key reason for the VJ to play live.

> *"The argument about why it is live, should you 'press play' has been raging essentially forever, and it will continue to rage, but before we couldn't do this live feedback, the event back into itself that we can do now, and that puts VJs centre stage and gives them a reason to be there." (Elliot)*

To Andrew, the value of playing live lay in making each performance a unique event that is different for each audience. He associated the uniqueness of a performance with the possibility of the performer responding to the environment, be this through direct technology-mediated interaction with the audience or environment, or more subtle improvisational responses. Andrew attributed the resulting uniqueness to a sense of intimacy and personal significance felt between the VJ, audience and performance.

> *"This is our thoughts, this is our ideas, this is the thing that we are trying to convey; and it's almost like telling a story or telling something... you tell a story to someone in a pub and then you tell someone else, it's always going to be different, almost that personal thing." (Andrew)*

The inclusion of environmental and audience input, to create a responsive performance, might be considered an effort to reinforce the transience of live performance. As was discussed in Chapter 2, notions of transience in live performance, such as those heralded by Phelan (1993), are being eroded by the possibility of replication through recorded media. These concerns would seem particularly relevant to VJ practice as the use of recorded media (e.g. video) in performance makes identical repetition of a performance a very realistic proposition. Therefore, the evident desire amongst participants to create responsive performances might be interpreted as an active attempt to imbue their work with qualities of transience, in answer to this challenge. Consequently, it is suggested that designers wishing to support such experiences in VJ practice might be well advised to explore the design of systems that support, e.g., interaction with the audience.

4.7.4 Further Insight from the Creative Responses

The Creative Response phase of the approach led to the creation of four short videos. Each video represented a response to a particular vignette, created by the participants it featured. As Andrew was a collaborator on both the Kinetxt and 3D Disco performances, he contributed only to the 3D Disco response. Three of the responses were short re-edits of the footage of our film, while the Kinetxt response was an ad-hoc performance. In the following sections, each response is described,

alongside the rationale that its creators provided. Additionally, each vignette is analysed to understand how its content clarifies, contrasts and extends the themes developed in the previous section.

4.7.4.1 3D Disco

The 3D Disco response began with footage of the performers preparing audio and visual material in their studio. The performers were shown quietly concentrating at their laptops while a heartbeat like rhythm played in the background. These scenes continued for nearly two and a half minutes until the final 40 seconds of the response where footage of the performance was shown. When discussing their response Andrew and Elliot commented that by creating an imbalance in the footage of pre-production and performance, they hoped to emphasise the hours of work that are spent preparing materials compared to the relatively short duration of the live show. Andrew attributed this to the anaglyphic visuals, which he said must be perfectly produced in order for their 3D effect to work.

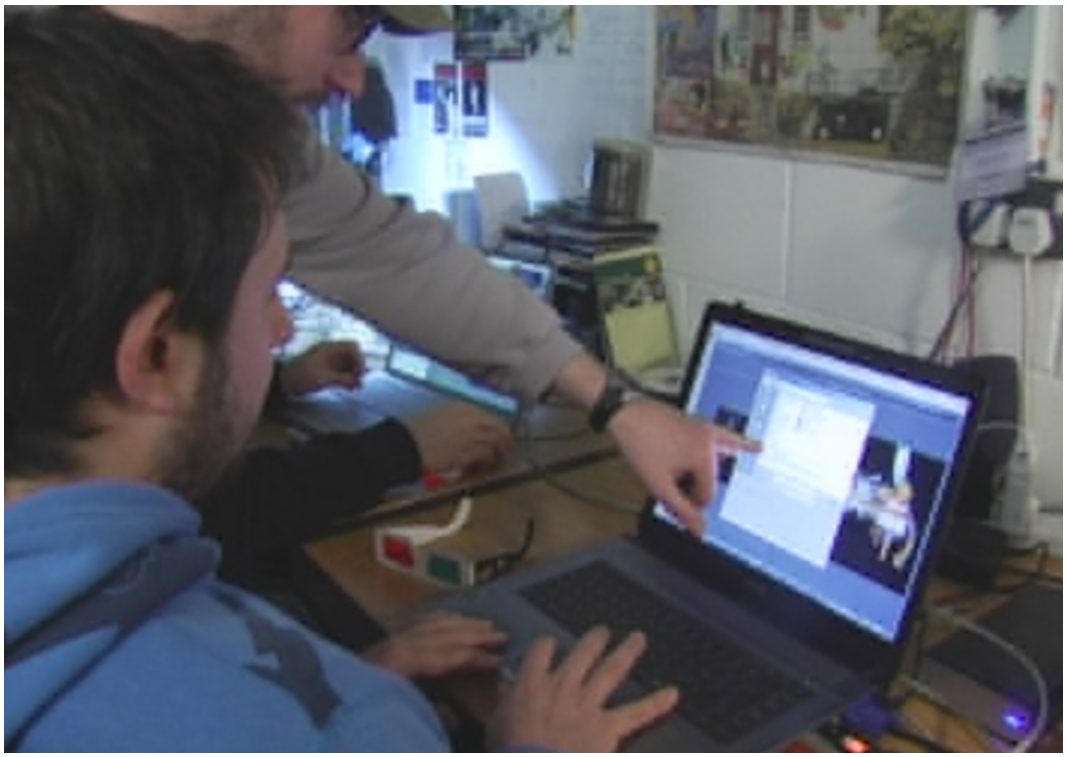

Figure 21: The 3D Disco response showing the laborious preparation required to create the visuals for the performance

By commenting upon the imbalance of creativity and manipulation between pre-production and performance, the response stressed that the limitations

Andrew and Elliot face in terms of manipulable media are rooted in the format of the visual materials utilised, rather than methods of control. Therefore, if designers are to address this issue, the response suggests that designs may have to go beyond the provision of novel control devices (e.g. new forms of hardware control surfaces) to explore how different forms of media might be employed in VJ practice to increase potential for manipulation during the moment of live performance.

Furthermore, the response demonstrates that, despite these limitations in terms of manipulation, Andrew and Elliot were able to achieve their goals of a pride-worthy piece that was evocative of audience enjoyment. Hence, the response suggests that if interactive technologies are to be designed that are supportive of the essential experiential qualities of VJ practice, they need not embody all of the themes defined in the previous section. Rather, an appropriate combination, which establishes a trade-off between the potentially conflicting demands of the performer, may suffice.

4.7.4.2 Electro-Flamenko

The Electro-Flamenko response commenced with shots of musicians and dancers alongside Alasdair as he performed. Alasdair overlaid a monologue over this section of the response that described his desire to share with an audience links between sound and image that he holds in his mind. Following this, a two-minute sequence of visuals was played. The visuals quickly skipped and looped in synchrony to the sound of a recording by Electro-Flamenko.

Alasdair stated that the first half of the response captured the different strands of music and dance that, together with his visuals, entwine to produce the Electro-Flamenko performance. As a result, he believed these images best illustrate what it means for him to VJ in a live band. He described the second half as a live demonstration of his work and stressed the importance of the material featured being produced with only the tools he uses in his actual live sets. He hoped that this would express how essential it is that his work is live and how he could never "just turn up and press play".

Figure 22: Alasdair's Creative Response, illustrating his visual style

Prior discussion noted that performances might be augmented with meaning such as narrative to make them more interesting and conceptually meaningful for the performer. Alasdair's monologue however suggested that the communication of links between sound and image is an activity otherwise impossible without participation in VJ practice. Therefore, the role of communicative expression in Alasdair's performance is brought to the forefront and, thus, stressed to underpin his practice in a way not revealed during the earlier analysis.

4.7.4.3 Kinetxt

Toby presented a short performance of Kinetxt on his laptop. The Kinetxt environment was configured to present passages of a script, which Toby read as they arrived on the screen as if they were contributions from an imaginary audience. Initially the passages described the desire to create a show that embraces the environment and the moment of the performance; thus, creating something that is "beyond broadcast". Next passages were read, from the imaginary voice of Kinetxt, which spoke of its existence as an entity or actor that creates an immersive environment by responding to the audience, the performer and the drawings of graffiti artists.

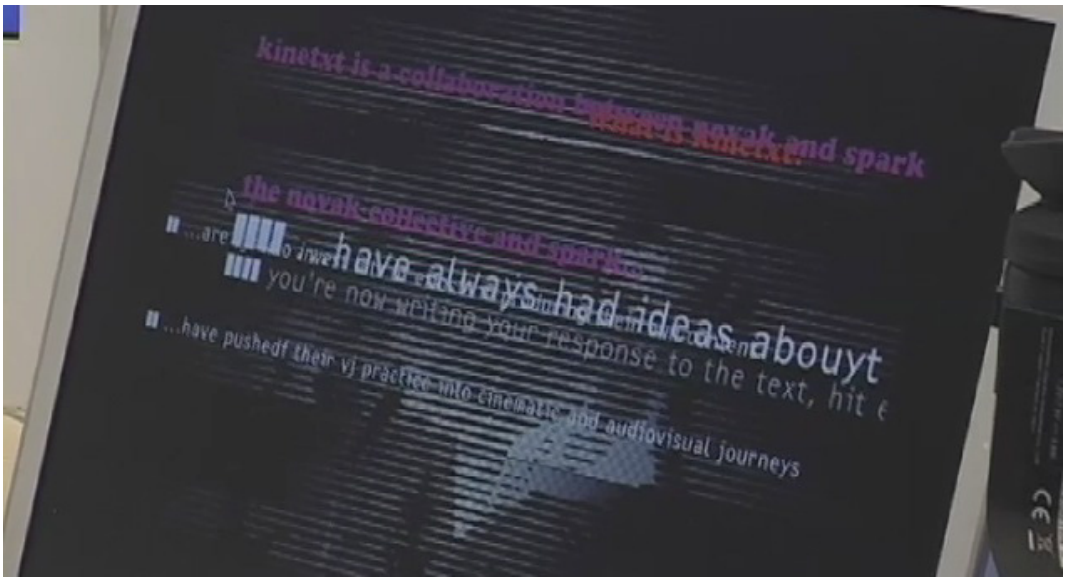

Figure 23: Toby's laptop screen showing Kinetxt during his Creative Response

Toby stated that, as Kinetxt is an experimental live performance, he made the response in an experimental and live way. He described Kinetxt as a "story telling experiment" and said that if Kinetxt cannot tell its own story then somehow he and Andrew fail. Toby's desire to perform an instance of Kinetxt, rather than re-edit one captured on film, suggested that he believed that to truly understand Kinetxt, an audience must witness it in action as it facilitates storytelling in response to the environment it inhabits. By showing Kinetxt live, Toby was able to stress the differences between viewing a video of a responsive performance and experiencing one at first hand. Therefore, Toby's response might reinforce the position that rather than just providing new sources of inspiration, the incorporation of environmental aspects into a performance instils live performances with a sense of *being there* (i.e. transience, variation, participation and community) that distinguishes a live performance from its re-presentation in recorded form.

4.7.4.4 Tron Lennon

Throughout the Tron Lennon response, short sounds played and looped in tandem with video clips of both John and Paul manipulating their instruments and controllers. At points, the sound stopped and footage of Paul speaking about the turntable as a tactile controller was shown. At one point visuals were scrubbed through in time with a video of Paul's hand scratching a record. The response

concluded with a clip of a man speaking about the unison between the sound of his speech and the moving image, throughout which the audio was out of synchrony.

Paul emphasised the importance of tactility in their performance through the response. He hoped that footage of interaction with his equipment cut with simple movements and fades of visuals would illustrate his desire for direct and intimate mapping between physical gesture and video. John hoped that by looping short video clips and sound samples together he could demonstrate his desire to create rhythmic patterns with video, similar to those he creates when improvising with sound.

Paul and John's response highlighted a desire for controllers that afford a strong relationship between physical gesture and manipulation of visual media. This is referred to as tactility by the pair and as such stresses the important role played by the physicality of controllers, and the relationship afforded with underlying media, with regard to the notion of haptically direct interaction. Therefore, a designer creating a tool, for Paul and John's VJ practice at least, would be well advised to consider the relationship between the physicality of the performer's gestures and underlying visual media.

Figure 24: Tron Lennon's Creative Response illustrating the collaging of video media, which the pair wished they could achieve in their current visual practice

Perhaps, the most interesting aspect of the response, however, was Paul and John's choice to use the video editing equipment provided to prototype, and hence demonstrate, forms of interaction that were desired, but not yet possible, in their current VJ practice. For example, physical gestures tightly synchronized with the manipulation of video demonstrated the immediate and visible interaction that although present in the pair's audio practice, was thus far unattainable in the visual arena. Consequently, the potential of the Creative Response activity as a means to communicate unrealised and therefore potentially otherwise ineffable aspirations for future developments to a practice was highlighted.

4.8 Reflection on the Findings

The study, and subsequent analysis, presents a number of compelling findings that contribute to the understanding of live performance and its relationship with the design of interactive technology developed in this thesis. Furthermore, it is argued that these findings will have implications for the design of interactive technology for live performance, which will be directly applicable to the practice-led aspects of the research conducted in this thesis and the practices of others designing interactive systems for VJs, and potentially those in related domains of live performance. In this section, the key findings resulting from the application of the design approach presented in this chapter are highlighted, alongside a number of recommendations for how these findings might be used by interaction designers.

4.8.1 Developing Understandings of Live Performance

Many of the themes identified by the findings of the study relate to the dimensions of live performance identified in Chapter 2. Consequently, the findings reiterate the importance of these issues to any understanding of live performance upon which interaction design might be based. For example, in Section 2.5 it was seen that the visibility and legibility of a performer's actions play a central role in establishing a sense of presence between performer and audience members. The common desire amongst the participants for tools and technologies that make their interactions visible to the audience reinforces this issue as a central consideration for the designers of VJing interfaces.

The varied relationships between particular dimensions of live performance and individual VJs' practices also highlight novel perspectives on issues affecting live performance. For instance, the theme responsive uncovers the role that technology-mediated audience interaction can play in creating a sense of uniqueness in live performances based upon recorded media. Therefore, the findings demonstrate the entangled nature of the notions of transience and community and suggest technology-mediated performer-audience interaction as a means to reinstate a sense of ephemerality, lost in many cases because of the incursion of recorded media into live performance. The diverse instantiation of views about particular issues across the different participants' practices, further reinforces the position that interaction design for live performance should adopt an idiographic approach, which considers issues of live performance as they are embodied in the lived and felt experiences of specific performances, performers and audiences, rather than as general and abstract rationalisations.

As well as evolving the understandings of live performance developed throughout this thesis so far, the findings also highlight a range of additional issues that might be of central concern to interaction designers addressing VJ practice and potentially the wider domain of live performance. For example, the findings grouped under the superordinate theme aspirational uncover the qualities of expression, and desire for personal improvement and evolution, as central values of a VJ's relationship with their practice. Additionally, and perhaps most crucially, the superordinate theme interaction demonstrated a range of additional subtle and complex issues relating to qualities of interaction with particular technologies (e.g. intimacy, physicality, immediacy) that are pivotal to VJs' experiences of performing.

4.8.2 Implications for Design

Examples exist in the literature of thematic analyses, such as the one presented in this chapter, being used to guide the processes of designers (e.g. Kaiser, Ekblad and Broling, 2007; Engström, Esbjörnsson and Juhlin, 2008). Therefore, it is expected that the themes developed in this chapter, will provide a range of insight that might be directly employed by designers (e.g. as motivation or guiding principles for design).

It is anticipated that the topics raised under the superordinate theme interaction will prove to be of particular efficacy to designers, as each sub-theme demonstrates how adopting a specific form or quality of interaction might affect how a design is experienced during performance. For instance, the findings grouped under the theme constraining interaction, question the often-adopted position that interactive systems for creative users should provide as much functionality and control as possible (e.g. Wessel, Wright and Schott, 2002; Shneiderman, 2007). Instead, a designer might be directed by the findings to create a tool for live performers that employs only a limited set of functionality or means of interaction, with the aim of creating a characterful interface with which the performer might enter into a dialogue.

A selection of other themes grouped under the superordinate theme interaction, indicated a desire amongst VJs for direct and intimate interaction with the visual media that forms their performances. Such direct and intimate interaction with visual media, was seen to pivot around the existence of a literal, or at least convincing, relationship between the performer's physical gestures and their effect upon the performance; the temporal immediacy of an interface's response to an interaction and the performer's capability to manipulate their materials during the moment of live performance.

McCullough's (1998, p 194) notion of a medium in digital craft arose as a particularly relevant conceptual framework through which designers might consider the VJs' desire for such intimate interaction with visual media. Alternatively, tangible user interfaces, which attempt to bridge the gap between the intangible bits of a computer and the perceptible atoms of the physical world (Ishii and Ullmer, 1997), might present a means by which the underlying content of a VJ performance can be given a tangible, haptic manifestation that the performer might hold and grapple with.

The findings grouped under the superordinate theme aspirational reveal the nature of the relationship between the VJ and their practice, and the crucial role this relationship plays in both the motivation for their practice and its continued evolutionary development. The participants were seen not only to participate in their practices, but also to have a significant personal investment that led to those practices being prized and nurtured over time. This relationship

between performer and practice was found to underpin one of the key factors that motivated the participants to do VJing, the desire to evolve and better their practices, often in response to novel technological possibilities. Such insight might suggest that designers should consider how interactive systems might be developed to be supportive of, or at least in keeping with, a performer's desire to push and evolve their practice both conceptually and technically.

For instance, these findings might be interpreted as suggesting inspiration and guidance should be drawn from work that explores how interactive systems might be crafted to develop a longitudinal presence in the life of the user, such as that conducted by Hallnäs and Redström (2002). Conversely, designers might be guided by these findings to embrace the expendable nature of their designs and, thus, take a pragmatic stance whereby systems are developed to fulfil the needs of a live performer only during a short phase of the development of their evolving practice.

4.9 Reflection on the Approach

The approach presented in this chapter was designed as a means to configure the early stages of a human-centred design process (i.e. the development of an understanding of people's practices) to support holistic engagement with issues affecting live performers' practices, with a particular focus upon surfacing insight into the participants' tacit knowledge. In this section, the approach is evaluated in terms of Polanyi's (1958, pp. 87-93) three domains of tacit knowledge, in an attempt to unpick which aspects of the approach might have been conducive to the surfacing of particular forms of tacit knowledge.

4.9.1 Surfacing Tacit Knowledge

Polanyi described tacit knowledge as occurring in three domains, where the inadequacy of the relationship between speech and thought makes the articulation of particular knowledge challenging. The first of these situations arises when knowledge is ineffable and as such, the speaker is unable to find the words to articulate the rich and intricate meanings underpinning what they know (Ibid., p. 87). For instance, a VJ might find it difficult to describe particular qualities that

comprise his or her personal aesthetic style, although this same style is easily recognised and created as part of their everyday practice.

It is argued that the use of documentary film as the basis of the approach presented in this chapter may have been particularly suitable for surfacing this kind of tacit knowledge. By allowing the participants to illustrate and demonstrate aspects of their practice, it is argued that the Creative Response activity allowed for the demonstration of elements of their work that might not have been easily communicated verbally. For instance, Alasdair was able to use the Creative Response activity to illustrate the connections he creates between sound and image, in a much richer manner than was possible during the verbal discussion of the focus group.

It is reasoned that the role of the film as a means to elicit ineffable knowledge might extend beyond visual demonstration. Moreover, the process of shooting, editing and finally discussing the documentary film with the VJs, led to the development of in-depth understandings of the participants' practices. It is argued that during this extended engagement, the filmmaker and I came to understand, or at least interpret, particular aspects of the VJs' knowledge that might have otherwise proved tacit. For example, throughout the filmmaking process a sense of the aspirations that drove each of the VJs' practices was gained, despite the qualities and values underpinning those aspirations not necessarily being immediately and easily articulable in the interviews or focus group discussion.

The proposition that the approach uncovered insight into the ineffable, or any other form of tacit knowledge for that matter, should be approached with caution, however. While it might be true that understandings were developed of the participants practices, it is acknowledged that these might not tally with the VJs' own understandings of the same issues and concerns. However, it is argued that by opening up our interpretations of the participants' practices for dialogue, the approach will have increased the chance of shared understandings of ineffable phenomena being established.

The second domain of tacit knowledge described by Polanyi refers to situations where a speaker and listener ascribe different meaning to words spoken, as the intended meaning of an utterance might be reliant upon a plethora

of contextual and historical knowledge that might not be possessed by the listener. For instance, Toby's discussion of his desire for a "transparent" interface might be entangled with a whole host of personal knowledge that is not communicated through his words alone. That is to say, to Toby, the meaning of the word transparent might relate to his experiences of performing with tools that were not transparent or his creative ideas about what form a transparent interface might take.

This second category of tacit knowledge would appear to be rooted in a listener's ability to make sense of what is communicated. Wright and McCarthy (2010, p. 18) describe our ability to make sense of experience not "as a process of absorbing predetermined meanings", but an "active transformation of situations with a view to resolving conflicts and ambiguities", which draws upon our personal actions, emotions, motivations and histories. The detailed and longitudinal engagement with the participants afforded by the approach allowed for the development of in-depth knowledge of the histories, preferences and aspirations of the VJs. It is argued that this contextual knowledge will have greatly enhanced the extent to which discussion of the participants' practices could be made sense of and, hence, our ability to uncover this second kind of tacit knowledge.

The dialogical nature of the approach arose as being a particularly valuable means to support the interpretation and understanding of the VJs' accounts of their practices. Firstly, the film offered a way to inquire about aspects of the VJs' practices that it was felt had not yet been adequately understood. For example, the 3D Disco vignette sought to foster a dialogue around Andrew's discussion of the role of improvisation and live creativity, which, while evidently important to his practice, seemed to conflict with the relatively fixed nature of his performance. These dialogues, around both our and the participants' interpretations of the practices presented in the films, continued throughout the focus group and Creative Response phases. Consequently, a dynamic arose whereby participants were inspired to elaborate upon aspects of their practices for which the lack of contextual and historical knowledge had prevented the development of an adequate understanding during the initial filmmaking process.

The final form of tacit knowledge described by Polanyi is said to arise in situations where knowledge is not yet fully understood by a person and, therefore,

cannot be easily articulated. Polanyi (1958, p. 93) referred to this kind of tacit knowledge as occupying a "domain of sophistication", where the "speaker does not know, or quite know, what is he talking about". Strong parallels can be drawn between the idea of knowledge that is crucial to our ordinary actions but is not yet fully understood and Schön's (1991, pp. 54-56) notion of reflection-in-action, upon which many aspects of the approach are based. Schön posited that by reflecting-in and -on his or her actions, a person might become aware of the tacit knowledge underpinning their ordinary practices. Therefore, it is argued that by aiming to foster such reflection-in-action, the approach might have assisted the VJs' in comprehending, and subsequently articulating, aspects of their practices that might have previously eluded understanding.

Reflection upon the experience of conducting the focus group suggest that it was a particularly advantageous means for surfacing this kind of tacit knowledge. As the participants viewed the films of each other's work, they were presented with novel examples of, and views on, issues that they were grappling with in their own practices. The juxtaposition of these different perspectives on shared concerns was seen to provide a means through which each VJ could understand what particular issues meant in the context of their own work. For example, discussion of the role of narrative in Toby's Kinetxt practice appeared to scaffold the other participants' reflection about the place of narrative in their own work.

It is believed that the Creative Response activity will have complemented this reflective surfacing of tacit knowledge fostered in the focus group. By asking the VJs to select and edit footage to evidence and further explore points made in the earlier discussion, the participants were given an opportunity to explore further the relationship between ideas discussed and their individual practices. John and Paul's use of the Creative Response to illustrate their aspirations for future performances is a particularly compelling example of this. By creating a mock-up, the pair was able to develop concrete views on how previously unattainable forms of live manipulation of video, envisioned during the focus group, could actually be incorporated into their future performances.

4.9.2 Producing Useful Insight for Designers

The previous discussion calls into question the idea of *surfacing* tacit knowledge as design insight. Surfacing implies that tacit knowledge is rendered articulate, so it might be fully explained in a written report, such as this chapter. While it is believed that tacit knowledge was articulated during the study, especially in the case of the domain of sophistication, it is also argued that in many situations the process through which tacit aspects of the participants' practices came to be understood did not involve articulation at all.

In the case of the ineffable domain, rather than relying on the articulation of tacit aspects of the VJs' practices as rationalised speech or text, the filmmaker and I developed our own similarly tacit understandings of complex and inarticulable issues through in-depth and dialogical engagement with the VJs. Moreover, in the case of the second domain of tacit knowledge, the development of such in-depth understandings of the VJs' practices provided contextual and historical cues that allowed sense to be made of the complex and subtle meaning of particular issues, in the context of the participants' practices, which might themselves have proved inarticulable.

This kind of inarticulate transmission of tacit knowledge raises questions about the efficacy of written accounts of people's experiences as a resource for design, such as the themes presented in this chapter. It is clear that the study's findings, in written form, contain a number of insights that will be inspiring and informative to designers. However, it is argued that a reader of the account might be unable to develop an in-depth understanding of the tacit aspects of the participants' practices, which rivals that developed by the filmmaker and me while conducting the study. Therefore, it is claimed that the approach developed in this chapter is not something that should be applied with the aim of producing written notes or reports that other designers then utilise. Rather, it is argued that interaction designers wishing to develop holistic understandings of key issues affecting the experience of live performance, which include insight into potentially tacit aspects of knowledge, should partake in the approach themselves; therefore, allowing for the development of their own in-depth and tacit understandings of the live performers for which they wish to design.

4.10 Conclusion

In this chapter, an approach was developed to support interaction designers in understanding the lived and felt experiences of live performers' practices. The approach was configured to pay particular attention to the surfacing of live performers' tacit knowledge. By applying the approach with a group of VJs, a number of findings were uncovered. These findings are expected to provide valuable inspiration and guidance to those designing interfaces for VJs, and potentially those in related domains of live performance. In this way, the approach can be seen to have elicited insight into key issues underpinning the experiences of live performers. Moreover, reflection upon the findings and the experience of applying the approach would suggest that insight into particular forms of the VJs' tacit knowledge was surfaced during the study.

Conversely, concerns were raised about the extent to which a written report of the findings of such an in-depth study of potentially tacit issues of live performers' practices could articulate the understandings developed by the filmmaker and me. Therefore, it was argued that designers wishing to elicit insight into the practices of live performers might be better served to employ the approach presented in this chapter themselves, rather than directly utilising the findings presented as a basis for their designs.

CHAPTER 5

Designing Waves

5.1 Introduction

In the previous chapter, an approach to understanding live performers' practices during the early stages of the design process was presented. Using a series of reflective activities centred on documentary-film, this approach sought to elicit insight into the issues that underpin live performers' experiences of their practices, including their tacit knowledge. The application of this method highlighted a complex and intricate set of views that VJs held with respect to interaction, which are expected to guide and inspire those wishing to design interactive systems for VJ practice and other related domains of live performance.

While it has been argued that such in-depth understandings of live performers' practices should be considered an essential pre-requisite for interaction design for live performance, it should also be noted that developing an understanding of the user is just the starting point for the design process. To propose a concrete interactive system for live performance the interaction designer must draw upon such understandings in the challenging, involved and creative process of *designing*.

In this chapter, this practice of designing interactive technology in response to these kinds of understandings of live performance is explored during the design and evaluation of Waves, a multi-touch interactive surface for VJ practice. The design of Waves followed an idiographic approach, which sought to engage issues of VJing closely as they were lived and felt in an individual VJ's practice. The case study of Waves illustrates how the use of an idiographic design approach allowed me, as a designer, to propose a concrete design response to an individual VJ's

practice, in a manner that was sensitive to the kinds of complex issues that underpin the experience of live performance.

The resulting Waves design comprises a number of innovative forms of interaction, which might be directly applied by, or provide inspiration to, those designing interfaces for VJing and potentially other related domains of live performance. Furthermore, reflection upon the idiographic approach employed highlights a number of concerns for those wishing to utilise a similar strategy when designing interactive technology for live performance and potentially other contexts.

5.2 Designing for Live Performance

Schön (1991, pp. 78-79) described design as a "reflective conversation" between designer and situation; a dialogue through which differing tensions (e.g. needs, aspirations, skills and materials) are addressed by the designer, resulting in the proposal of a concrete design response. In the case of the interaction designer wishing to respond to the account of VJ practice presented in the previous chapter, these tensions might include the differing motivations, aspirations or technological and aesthetic preferences of artists.

Schön's account, suggests that design is not an objective process, through which issues of practice are mapped to solutions. Rather, he argued that design is an activity that involves significant thought and creative participation by the designer, during the dialogical conception and iteration of a design response. The intricate and potentially tacit issues that underpin artists and audiences' lived and felt experiences are expected to make this activity of dialogical designing particularly complex and challenging in the context of live performance. It is expected that this challenge will be worsened by the multitude of different ways that the kinds of issues uncovered in the previous chapter are instantiated in different artists' practices.

In the previous chapter, it was shown that technology was an integral quality and motivation of many of the VJs' practices (e.g. Section 4.7.1.3). In some performances, the VJs were seen to select and combine technologies to suit their personal aspirations and artistic goals, while in others they were motivated by the desire to explore the possibilities of novel technology. Parallels might be drawn

between these facets of VJ practice and Fallman's (2003) pragmatic account of design, which is described as a process of adapting materials and tools at hand to meet a particular design situation. That is to say, the VJs studied might be seen to be conducting design already, as they creatively configure and draw upon available technologies to realise the aspirations of their practices.

The positioning of design as a creative activity and, more crucially, the live performer as a creative practitioner with well-formed ideas about design, highlights a potential means by which the designer might uncover and engage insight that will guide a concrete design response to issues of live performance. If a live performer's creative views on design can be uncovered and examined, they might be harnessed as insight into how the relatively abstract issues of live performance discussed throughout this thesis might be reified into concrete designed artefacts.

However, engaging with a live performer's views on how design should respond to their practice might prove to be a challenging activity. The consideration of design as a pragmatic, "reflective conversation" (Schön, 1991, pp. 78-79) suggests that the knowledge underpinning a designer's response is not pre-formulated. Rather, the kind of understandings that guide a designer might often arise through active participation in the design situation. Hence, it is expected that the live performer's views on design, which the human-centred designer might wish to uncover as design insight, may only come about through their active participation in the process of designing (Ibid., p. 50).

5.3 Idiographic Design

Idiographic design can be identified as a category of interaction design that focuses upon detailed and subjective accounts of individual's practices. Previous examples of idiographic design include the autobiographical approaches surveyed in Chapter 3, where design was based upon a detailed concern for the designer's own experiences and Wallace's (2007) exploration of digital jewellery, where empathic engagement with the personal histories of individual subjects allowed notions of beauty and personal significance to be considered in the proposal of bespoke artefacts.

In this chapter, it is argued that the in-depth and subjective perspective offered by an idiographic approach, might form the basis of interaction design for live performance that is sensitive to the subtle and complex issues underpinning individual live performers' practices. Furthermore, it is argued that the intimate relationship between the live performer and the design situation afforded by idiographic design, will allow them to become involved with the ongoing design process; therefore, enabling their standing and knowledge as a creative practitioner to be leveraged as further insight for design.

5.3.1 Valuing an Individual's Lived Experiences in Design

Previous accounts of idiographic design suggest that the approach may provide a valuable means of continuing the holistic engagement with live performers' lived and felt experiences developed in the previous chapter, into the later creative stages of the design process. The principal characteristic of idiographic approaches is the attention paid to the personal and subjective nature of people's lived experiences. This stands in contrast to traditional nomothetic approaches to design, which privilege "objective, quantitative, reproducible and formal representations" of people's experiences (Sengers, 2006).

While nomothetic approaches to interaction design have been proven useful in many settings, questions have been raised about their appropriateness in contexts such as live performance where the success of a design pivots around the designer's ability to engage with subtle and complex aspects of people's lived experiences. Sengers (Ibid.) argued that attempts to base design upon objective and formal accounts of practices might result in designs that disregard the inherently subjective qualities that underpin people's experiences of interaction; therefore, resulting in designs that fail to "enrich our everyday quality of experience". Boehner, Sengers and Warner (2008) argued that there exist ineffable qualities of experience that are defined through and are hence irreducible and inseparable from their instantiation in individuals' lived experiences. Consequently, they argue that approaches to design based upon the "codification and generalisation" of people's experience will not allow a designer to engage the kinds of personal and tacit knowledge that might be definitive of artists and audiences' experiences of live performance.

By contrast, these accounts highlight the potential of an idiographic design strategy as a means by which interaction designers might engage experiences of live performance in design, as they are lived and felt in actual live performers' practices.

5.3.2 Drawing Creative Insight from an Individual's Experience

In addition to fostering in-depth engagement with people's lived experiences in design, idiographic approaches also stand out as a particularly compelling mechanism to assist the designer in the creative proposal of a design response. It is expected that designing in response to the kinds of subtle and complex issues that underpin the experience of live performance will be a challenging task, especially if those issues are considered in abstract form. Idiographic design might assist the designer in this respect by allowing such issues to be considered through their detailed and concrete instantiation in an individual live performer's practice.

Moreover, it is hypothesised that the close and individual engagement afforded by the approach will allow the designer to pay detailed and idiosyncratic attention to the live performer's creative views about how design should respond to their practice; therefore, eliciting additional design insight from their standing as a creative practitioner. Due to the emergent nature of the knowledge that might underpin design (i.e. design ideas are likely to be developed through participation in the act of designing), such attempts might depend on the possibility of actively engaging the live performer in the design process, potentially through their active participation in the proposal of the designed artefact.

5.4 Designing for an Individual's Practice

The idiographic design of Waves was centred upon a close design-led engagement with Andrew, one of the participants from the previous study. This engagement commenced with three semi-structured interview sessions. Each session lasted approximately one hour and followed a script that addressed topics uncovered during the study of VJ practice reported in the previous chapter. The interviews sought to uncover the relationship between these relatively abstract themes and Andrew's authentic experiences of VJ practice. By seeking to understand how these concepts related to the lived experiences of an individual performer, it was hoped

that concrete insight might be uncovered to guide the challenging act of creatively proposing a design response.

The interview sessions sought not only to uncover the existing relationship between issues of VJing and Andrew's practice, moreover, they were configured in a number of ways to invite Andrew into the design situation posed by his practice. As a result, it was hoped that he would be stimulated during the course of the interviews to enter into the dialogical process of designing, through which insight into his ideas about how design should respond to his practice could be discovered.

To achieve this, the questions posed to Andrew during the interviews were intentionally focused upon eliciting his views about the relationship between interactive technologies and the issues affecting his practice. Additionally, a number of visual aids were used during the course of the latter two interviews. These aids, which comprised both images and videos of novel interactive technologies (Figure 25), sought to broach discussion of potential design ideas in relation to the technologies they illustrated. For example, various videos of the reacTable (Jordà, Geiger, Alonso and Kaltenbrunner, 2007) were used to inspire a discussion of the possible role tangible interaction might play in a design for Andrew's practice.

Figure 25: A samples of the images used as visual aids used during the interviews

Finally, a sketchpad and pens were made available to facilitate the quick illustration and development of design ideas. It was hoped that by providing these materials, Andrew and I would be given a means to put forward concrete design

ideas; therefore, further framing the sessions as a design activity, rather than a general inquiry into his practice.

It was hoped that these small configurations of the interview process would provoke Andrew to deliberate on how design could respond to his practice and, therefore, imbue his answers with knowledge developed through active consideration of a creative design response to the relationship between the issues discussed and his personal lived experiences (i.e. designing for himself).

5.5 Analysing Andrew's Responses

Transcripts of the interviews were analysed using interpretive phenomenological analysis (IPA). IPA is a method of analysing qualitative data that specialises in developing an understanding of the experiences of an individual, who can offer the researcher meaningful insight into a particular topic or experience (Smith, 2007). Consequently, IPA was expected to be a suitable method to develop the detailed and idiosyncratic understanding of Andrew's practice required of the idiographic approach.

According to a procedure for IPA set out by Smith (Ibid.), the transcripts were first open coded to highlight excerpts that offered insight into the relationship between the issues of VJ practice, developed in Chapter 4, and Andrew's personal experience of VJing. Additionally, passages were coded that proved to be interesting, surprising or in any other way significant. Finally, connections between the emergent themes were identified and iteratively grouped.

In the following sections, the four key themes generated by this analysis are described. These themes can be seen to represent subtle variations upon the more general issues of VJ practice and live performance uncovered throughout this thesis. Consequently, it was found that the themes provided insight into the relationship between issues of live performance and an individual VJ's practice, upon which a concrete design response could be based.

5.5.1 Salient Interaction

Andrew stressed how important it was for the audience to experience his performance as a live occurrence. However, he questioned whether the tools of his

current practice – a laptop computer, which runs the commercial VJ software Modul8 (GarageCUBE, 2012) – would be supportive of the "audience's ability to recognize and experience [his] action as being live". He expressed an anxiety that in the worst case a member of the audience might ask, "Well, is he doing anything?" By contrast, he imagined the design of tools that might convey a "sense of really controlling". Andrew's concerns are characteristic of the laptop performer problem (see Section 2.5). Prior research, which addresses the laptop performer problem in VJ practice, has proposed that interfaces should be made transparent so that the audience might "see the performer's actions and understand what is happening behind the scene" (Lew, 2004).

Andrew exhibited resistance to the notion of a transparent interface, stating that he did not want the audience to see his practice in "every detail" as he feared this might make his performances too "descriptive and literal". Instead, he imagined the creation of a dynamic, which he compared to that of a "stage magician", where just enough is revealed to allow the audience to grasp how a trick might be done, but enough is hidden to evoke a sense of intrigue and mystique.

Similar notions have been proposed under the label of magical interaction "where effects are revealed but the manipulations that caused them are hidden" (Reeves, Benford, O'Malley and Fraser, 2005). However, Andrew's proposal was different as he wished for managed partial obscuration of interaction; whereby a subtle revelation may evoke a sense of enchantment amongst the members of an audience. Such interaction is defined as salient, to stress Andrew's desire to be prominent and conspicuous, yet not transparent, literal or descriptive.

5.5.2 Coalescing Interface and Performance

While Andrew resisted notions of literal transparency, he expressed a desire to bring the graphical user interface into the audience's view, so it might be integrated as a visual element of performance. Ideas such as the projection of the GUI (graphical user interface) behind the performer or its replication on a large multi-touch screen were mooted. However, concerns with such approaches related to whether interaction with interfaces composed of knobs, buttons and sliders would be of interest to an audience (as they are "just control") and if exposing the

mundane nature of certain aspects of his performance might take away some of "the mystique" (see the previous discussion of salient interaction).

Andrew's concerns pointed to the possibility of having a GUI that could in its very essence (i.e. form, aesthetic and use) be a captivating visual element of a performance in its own right. He imagined an interface that had visual beauty, but also physicality, on the part of the operator, analogous to that of a skilled turntablist's manipulation of vinyl records (i.e. a technology-centric interaction that is visually compelling to an audience). Andrew's views, therefore, suggest a form of interaction whereby the GUI is more than simply a means of control, but coalesces into the performance and is experienced as part of its core aesthetic and artistry.

5.5.3 Generative Manipulation

Andrew exhibited a desire for an experience of *creating* visual media during performance, rather than editing content that was created in another space and time (i.e. in a studio before performance). Due to their reliance on pre-rendered video media Andrew's existing tools primarily supported the latter editing-like interaction, although with the ability to apply effects and rearrange video frames.

Andrew described how such editing-like interaction restricted the potential for experimentation and improvisation during performance and led to an imbalance between the amount of creative work done before and during performance. Consequently, he felt that his personal experience of a performance as a live event was diminished. He even went as far as suggesting that if the majority of the creative work was completed before he gets on the stage "Is it not just better to make it into a film?"

In response to these concerns, Andrew envisaged forms of interaction that would allow him to feel as if he was "creating the actual visual content bit, the source sample" or "painting from scratch". He suggested that algorithmic generation and direct manipulation of CGI might be more conducive of creativity in action (i.e. during a performance). The visual programming language Max/MSP (Cycling 74, 2012) was mentioned as a tool that might allow the performer to create a bespoke environment prior to performance, which affords the experience of live creation of visual content. This quality of Max/MSP raised the notion of

creative action prior to performance that brings about the experience of creating during performance. The term “generative” is borrowed from Andrew, to define interaction during performance that is experienced as an act of creation rather than editing.

5.5.4 The Interface as a Medium

In the final theme, a range of disparate qualities of interaction, mentioned by Andrew, are conceptualised in terms of McCullough's (1998, p. 194) notion of a “medium”. McCullough’s position considers technology as if it were the “material” or “instrumentality” of a craftsperson. Consequently, it was hoped that a frame would be found within which a concrete design response to these qualities of technology might be grounded.

Technologies were said to pose opportunities, which inspire new directions in Andrew's practice. Furthermore, technological limitations were perceived as a valuable mechanism for guiding and grounding creativity, in the context of the overwhelming space of potential directions that Andrew's practice could take. McCullough defines a medium in terms of both a range of possibilities that engage and stir the imagination and constraints that guide creativity (Ibid., p. 196). By considering Andrew's tools as a medium, akin to a physical material, a design might therefore enforce and explore the role that technical possibilities and limitations play in inspiring and guiding his practice.

Further discussion highlighted the value of the tight feedback loop that arises when complex, precise and high fidelity control is coupled with tools that afford an immediate response. Andrew described the importance of immediate feedback from an action and how this allowed him to “constantly build on something” while experimenting. McCullough described how a medium must not only provide a constrained space of possibilities, but also allow these possibilities to be explored as if the user were “coaxing a material”; and that a medium has a “density” that presents a “continuum of possibilities” through which a craftsperson (in this case Andrew) might flow between during practice (Ibid., p. 196). Andrew's desire for a tight feedback loop during performance can be interpreted as a direct call for medium-like interaction whereby he is able to sense and respond to the

possibilities posed by his tools and materials in a continuous and dialogical manner (i.e. akin to a craftsperson physically manipulating a material).

5.6 The Design of Waves

In the next stage of the idiographic design process, an initial prototype of an interactive system for VJ practice, Waves, was developed. In line with the idiographic approach employed, the design sought to respond idiosyncratically to the issues and design ideas raised in the preceding engagement with Andrew's practice. Therefore, the design of Waves represents an effort on the part of a designer (i.e. me) to base design upon the lived and inherently subjective experiences of an individual live performer's practice. As such, it is argued that the design process and the resulting Waves design acted as both an exploration of idiographic design and an exemplar of its efficacy as an approach to facilitate the consideration of a live performer's lived and felt experiences in design.

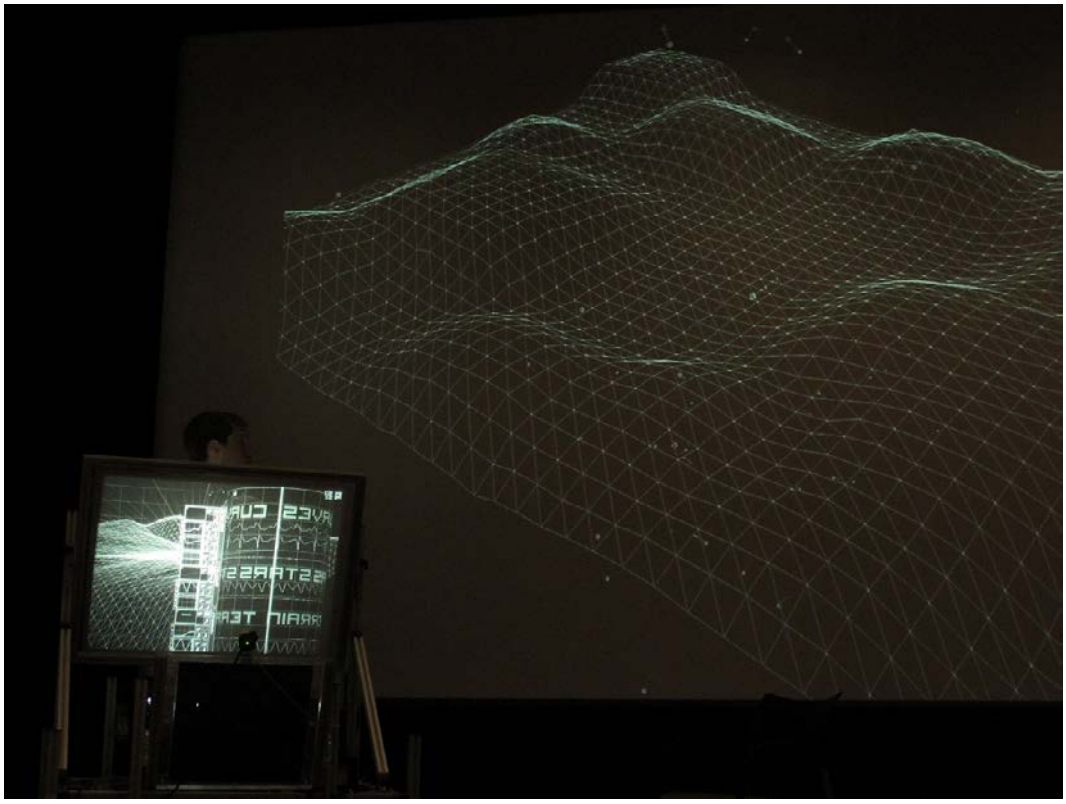

Figure 26: Waves, from the perspective of an audience member

The Waves design comprises three main elements: a large multi-touch surface, a bespoke GUI and visual content, which is projected on a large screen behind the performer (Figure 26). The rear of the multi-touch surface is left open,

so the audience can view the performer's manipulations of the GUI. In the following sections, the design of Waves is detailed alongside explanations of how aspects of the design, from its hardware form factor to individual interaction techniques, responded to the understanding of Andrew's practice developed.

5.6.1 Multi-touch Interactive Surface

The Waves design is based around a large (800 × 600mm) double-sided multi-touch screen (Figure 27), which I custom-built for the project[1]. This FTIR (frustrated total internal reflection) multi-touch enabled projection surface (Han, 2005) is mounted in an aluminium frame at a 22.5˚ angle to the vertical. A Point Grey Research Firefly FFMV-03M2MCS (Point Grey Research, 2012) camera is used in conjunction with the open-source Community Core Vision software (NUI Group, 2012) to track the position of touches on the screen. A technique is utilised whereby the IR (infrared) emitters of the FTIR screen are synchronized with the shutter of the camera in order to reduce interference from ambient IR light (e.g. stage lighting), which was expected to be present in the performance environment (Echtler, Sielhorst, Huber and Klinker, 2009). The camera is augmented with a band-pass filter, to prevent any remaining ambient IR light that differs more than ±50nm from the wavelength of the IR emitters from reaching the sensor. A projector (1024 × 768 pixels) is used to display the GUI on the rear of the FTIR screen, for both the performer and audience to view.

The multi-touch hardware configuration was a key element of the design response to Andrew's desire for salient interaction. Its large and distinctive form factor was designed to draw the audience's attention to the performer; therefore, amplifying his presence within the performance. By designing the screen so that the GUI was visible, it was hoped that the VJ's interactions would be exposed to the audience so they might be experienced as a live element of performance. The hardware configuration was vital in this respect as unlike, for example, the duplication of the GUI on a large projection screen; the performer's touches would

[1] The development of a multi-touch screen that was responsive and robust enough to be deployed in a live performance environment involved a substantial amount of research, which was conducted with a number of colleagues from across Europe. Whilst peripheral to the aims of this thesis, and hence not reported here, a detailed account of findings of this work can be found in (Schöning, et al., 2010).

be naturally coupled with the interface (Wensveen, Djajadiningrat and Overbeeke, 2004). Therefore, it was hoped that audience members would be able to observe the direct relationship between the performer's gestural interactions and elements of the interface.

Furthermore, the striking presence of the large double-sided screen was designed to contribute to the transition of the GUI from simply a controller, to an element that is experienced as a compelling aspect of the visual performance. In this respect, it was a crucial feature of efforts to design a performance that coalesced interface and output together into a single visual spectacle.

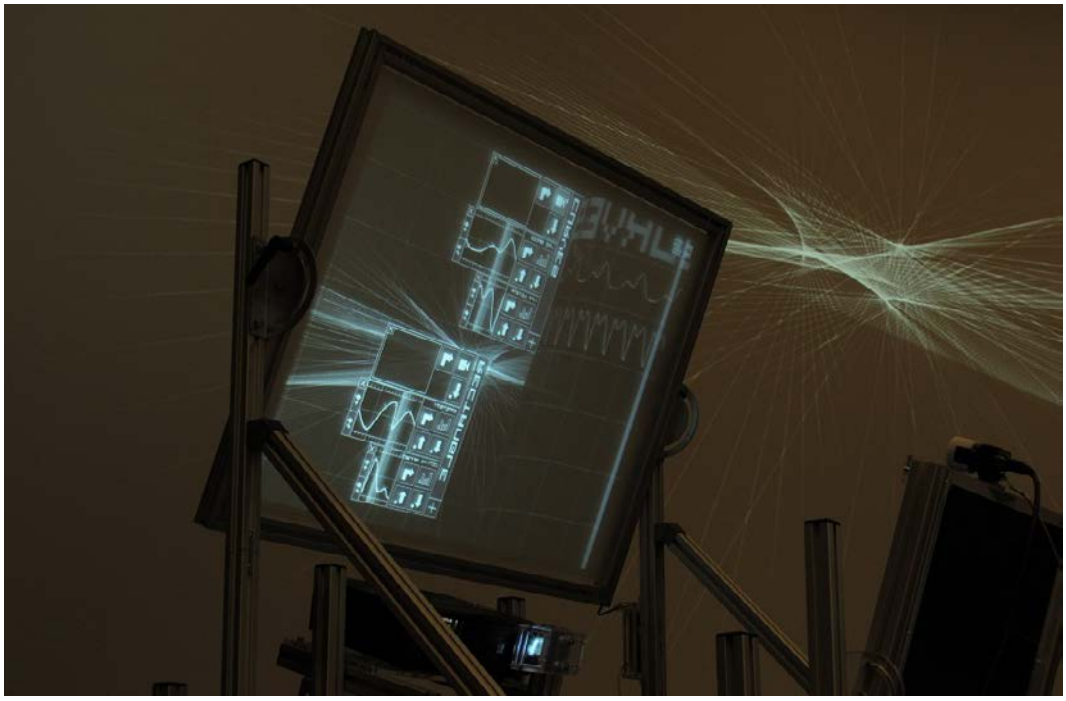

Figure 27: The multi-touch interactive surface

5.6.2 Visuals

The visual content of a Waves performance comprises a set of interactive CGI (computer-generated imagery). Each visual is defined by a finite set of parameters, which control its behaviour. In the case of a visual that displays a mesh-like terrain on the screen (Figure 28) these parameters might typically control the transformation of vertices. Additionally, more complex “algorithmically mediated interaction” (Bowers, Hellström and Jää-Aro, 1998) is made possible by allowing the performer to manipulate the parameters of processes that generate the form of

a visual, such as a particle system where parameters control the generation and behaviour of particles.

In the current implementation of Waves, the visuals are created in the programming language C++, using the graphics libraries OpenGL or Open Frameworks (2012). This programmatic method for creating visuals was chosen in response to Andrew's desire to learn these technologies during the course of the project and thereby have the ability to exercise more fine-grained control of the visuals in his performance. However, the system could be adapted easily to function with one of the many tools that provide a simpler non-programmatic framework for the composition of CGI, such as Max/MSP (Cycling 74, 2012) or Blender (2012)[1].

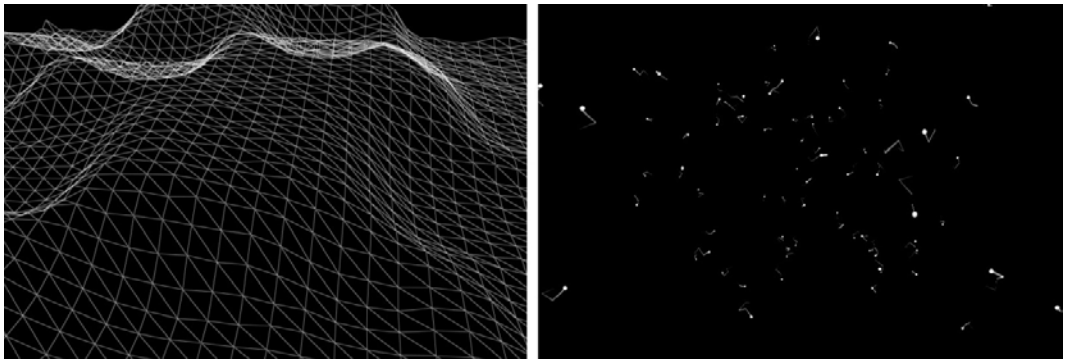

Figure 28: Waves visuals, (left) mesh-like terrain and (right) particle system

The underlying implementation of the visuals as CGI was essential to the design of generative manipulation. The tools for VJ performance that Andrew had experienced in the past were primarily based upon the manipulation of rendered video clips. Ignoring the complexities of compression, video clips are represented in the computer's memory as a grid of pixels, which each store a colour value. As these pixels store no semantic information about what is displayed in each frame, manipulation beyond the application of filters or the re-ordering of frames is non-trivial. The CGI visuals of Waves are represented as a model, which is rendered in real-time for presentation to the audience. Consequently, the essential semantic information about the contents of the visual is made available, allowing for complex manipulation of its form during performance.

[1] The Waves system has since been adapted to control visuals produced in these environments. It is hoped that this work will support the release of the software as an open-source project.

By extending the VJ's vocabulary of interactions, to include complex and intricate manipulations of the structure, form and behaviour of visuals, it was hoped that interaction akin to “creating the actual visual content bit, the source sample” or “painting from scratch”, which Andrew stated to be the essence of generative manipulation, would be afforded.

5.6.3 Graphical User Interface

The GUI is composed of two main elements (Figure 29). First, Wave Objects provide a representation and mechanism of control for visuals. These consist predominantly of spline curves, which the user manipulates to set the values of a visual's parameters over time. Secondly, the Wave Cylinder is a large column to the left of the user interface, which acts as a player for Wave Objects. When an object is dragged into the proximity of the cylinder, it is attached then rendered onto the large output screen.

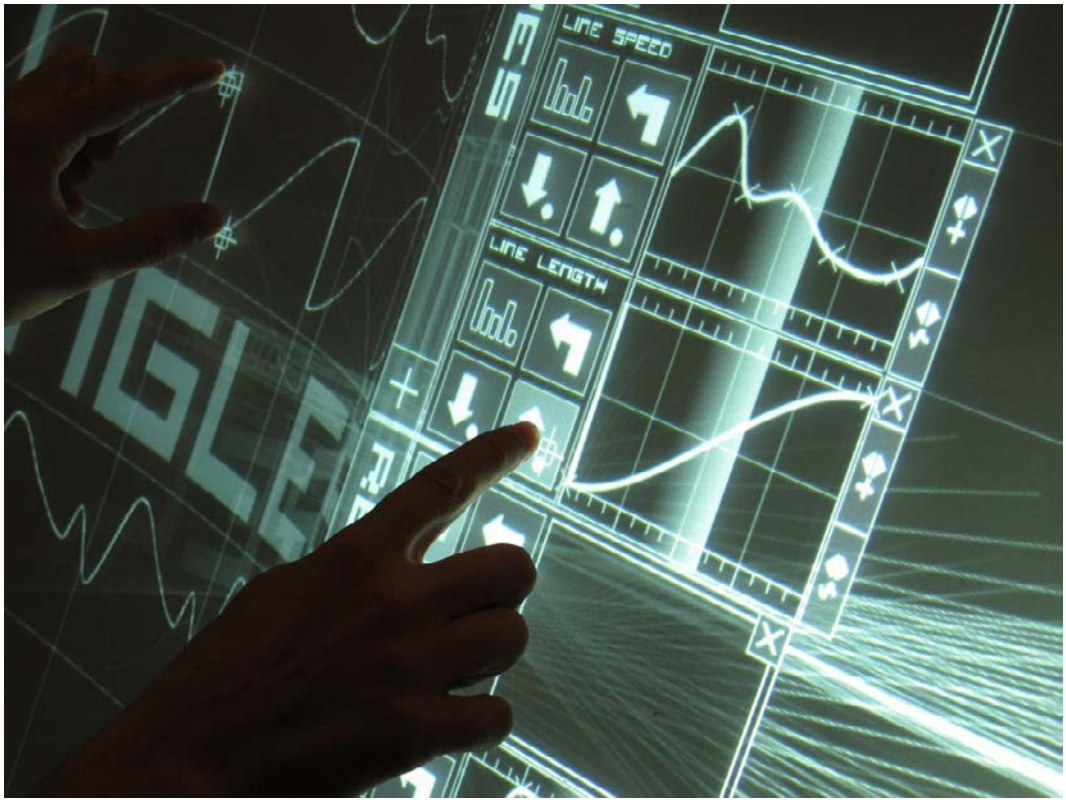

Figure 29: The Waves GUI

The interface is zoomable, using a two-finger gesture common to many multi-touch interfaces. This allows a more detailed view and control of any GUI element. The output displayed on the main screen is replicated behind the

interface so the performer may observe the results of their interactions without looking away from the interface. Furthermore, due to its simple skeletal design the GUI takes on the aesthetic of the visuals it overlays. Like the visuals, the GUI is implemented in C++, with graphical elements rendered using OpenGL.

5.6.3.1 Wave Object

The Wave Object is the basic element of the GUI and each is directly associated with a visual in the performance. A Wave Object is comprised of a number of tracks, which each control a parameter of their associated visual. For example, the Wave Object in Figure 30 has three tracks that control the opacity, speed and jitter parameters of a particle system.

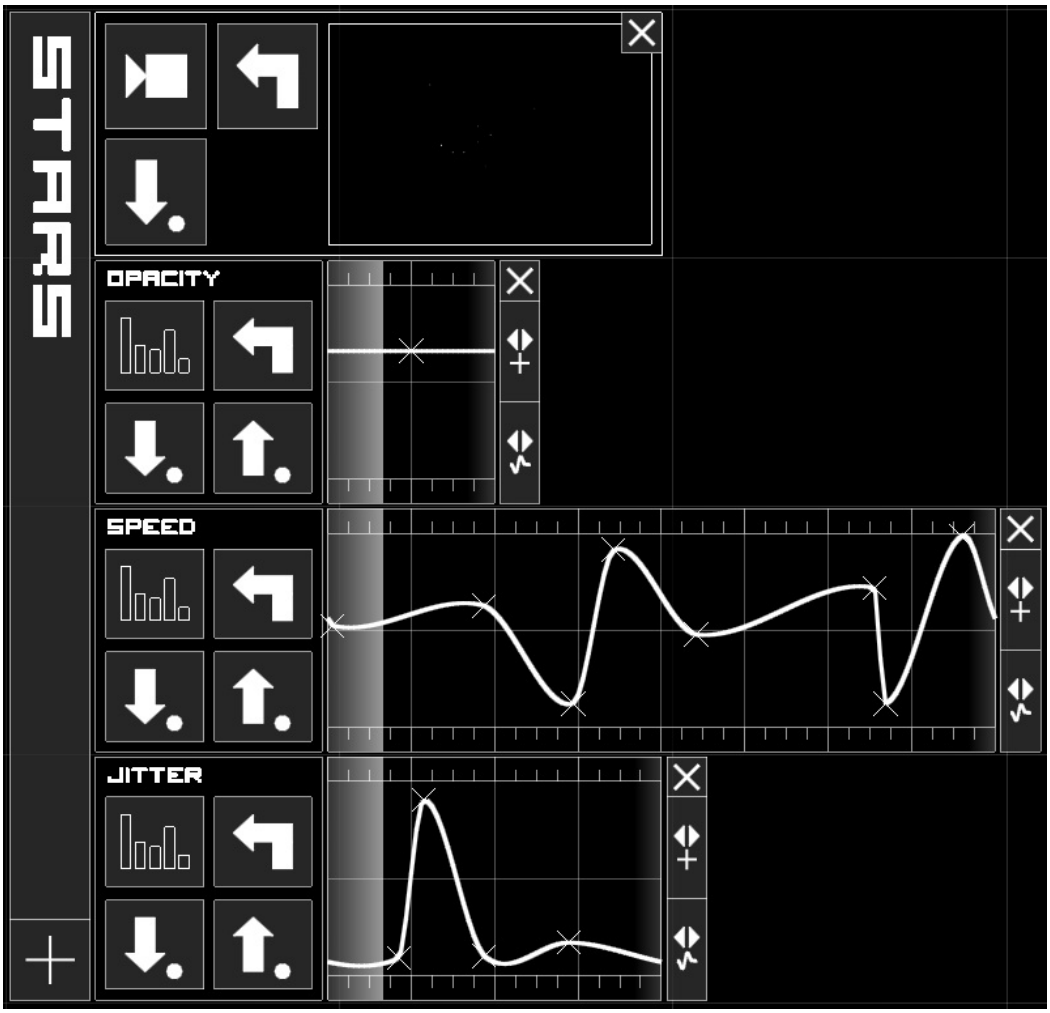

Figure 30: A Wave Object that is associated with a particle system visual

Each track has a spline curve that represents a parameter value over a time (where time is plotted in units of musical beats). To change the shape of the curve,

the user holds a finger against it; a control point then appears that may be moved using a dragging gesture. If a single control point is added to the line, the value of the parameter can be controlled in a manner similar to a fader on a mixing desk. However, if multiple control points are added, the curve will smoothly interpolate a set of parameter values. The user can selectively hide parameters, in order to save screen real estate, by touching a cross icon in the top right hand corner of each track. When a parameter is hidden, its values are set to a pre-determined default value. Hidden parameters can be revealed using a menu in the bottom left corner of the Wave Object.

The spline-based interaction of the Waves Objects was designed with a view to achieving simplicity and clarity. It was intended that as the audience see the VJ directly manipulating simple spline curve forms, they would be able to grasp that the actions of the performer are having an effect upon the CGI visuals of the performance. In making this connection, it was expected that the audience would draw upon their prior knowledge of curves as mechanisms for representing continuous ranges of values (i.e. line graphs).

The aesthetic of the Waves Object was a key consideration when designing for a GUI that is coalesced into the performance. The spline curves provide a functional means of interaction with the performance while avoiding the presentation of traditional widgets such as knobs and sliders to the audience. Moreover, the complex gestural manipulations of the spline curves were designed to have a beautiful, skilful and fascinating aesthetic that would transition the action of the VJ from *just controlling* to being an enthralling display of its own.

Finally, the design of the Waves Object responds to the notion of interaction with a medium and McCullough's (1998, p. 196) characterization of a dense medium, which provides the user with a continuum of possibilities that can be sensed and manipulated in such a way that the interaction might flow between states. When designing the spline curve interaction of the Wave Object, inspiration was drawn from a concept of a malleable virtual form with a shape directly related to the parameters of an underlying visual or sound, as was proposed by Andrew in the interviews. By directly exposing parameter values in a tangible form on the screen, it was hoped that a sense of directness of interaction would be afforded,

which would enable the user to enter into a dialogue whereby the state of parameters are sensed and responded to in a precise and continuous manner.

This approach is referred to as data-centric interaction with a medium, as the underlying parametric representation is considered the medium with which interaction occurs, rather than its visible rendered form. Such an approach shares similarities with interaction designs based upon metonymy, where the underlying properties of a system are exposed to the user rather than encapsulated in a metaphor (Bertelsen, Breinbjerg and Pold, 2007).

5.6.3.2 Wave Cylinder

The Wave Cylinder (Figure 31) is a large rotating column on the left side of the interface. When one or more Wave Objects are dragged onto the cylinder, they become attached and their associated visual is rendered to the main performance screen.

Figure 31: The Wave Cylinder with a Wave Object attached

Once a Wave Object is attached to the Wave Cylinder its spline curves are rendered onto the cylinder's outer face. Values for each parameter are extracted as the intersection between the spline curve and the play-head, a vertical line that spans the centre of the cylinder. In this way, the different parameter values in a pattern are recited at a speed governed by the rotation of the cylinder. One full rotation of the cylinder represents the passage of 64 beats. If a track is shorter than 64 beats in length, the pattern is repeated to fill this space. The speed of rotation is

set in terms of BPM (beats-per-minute); this can be set either numerically or by tapping a button in time to the beat of a piece of music. Furthermore, the VJ can directly interact with the angle of rotation of the cylinder in order to either scratch it, as a turntablist scratches a vinyl record, or to make a subtle adjustment to synchronise it with the beat of a piece of music.

The Wave Cylinder was designed to augment the saliency of the Wave Objects by providing a visible link between the form of the spline curves and the temporally progressive nature of the performance. Its form was inspired by the rotating drums of cylindrical music boxes and player pianos and as such implies that the form of the splines, when overlaid on the cylinder, represent the progression of a series of values over time. Furthermore, the smooth rotation of the splines overlaid on the cylinder contributes to the enchanting and intriguing visual aesthetic of the Waves interface, furthering the level to which it is coalesced into the core visual elements of performance.

5.6.4 Design Iteration and Andrew's Participation

Initially, Andrew was not invited to participate in the development of the Waves design. However, as functional prototypes were developed, and the process of evaluating Waves' relationship with Andrew's practice (Section 5.7) commenced, Andrew was invited to experiment with the design on multiple occasions. In a similar manner to the visual aids of the earlier interviews, the design was found to act as a form of probe during these meetings, inspiring Andrew to reflect about the potential place of the design in his practice. As a result, in-depth discussion of the design and its potential relationship with Andrew's practice arose during these sessions. Consequently, Andrew and I proposed a number of design ideas, which were then rapidly implemented and presented back to him to in following sessions of experimentation with the system. Therefore, by inviting Andrew's direct input into the dialogical process of design, the approach became increasingly participatory in its later stages.

Many of the design ideas resulting from this dialogical iteration involved the addition of simple features, added to support Andrew's evolving method of working, and eventually performing, with Waves. Examples of these subtle design alterations included the need for cueing functionality, to allow a visual to be

previewed on the interface but not on the large projection, and the ability to replicate a pattern of control points when extending the length of a Wave Object's track. Furthermore, a number of more substantial changes resulted from Andrew's participation in the design process. These changes are described in the following sections.

5.6.4.1 Pre-sets

Andrew's reflection on his prior experience with VJ tools suggested that at high-pressure moments in a performance it would be necessary for a spline curve to assume a pre-set form, such as a sine wave, immediately (e.g. in response to an error or an unexpected change in music). Furthermore, Andrew expressed a desire to catalogue pre-set forms, which could be called upon during different moments of a performance. Therefore, pre-set functionality was added to the Wave Object, which allows the VJ to call upon a range of pre-sets from a simple menu. These pre-sets can be defined, prior to or during a performance, by configuring the spline curve to a particular form and pressing a save button (Figure 32).

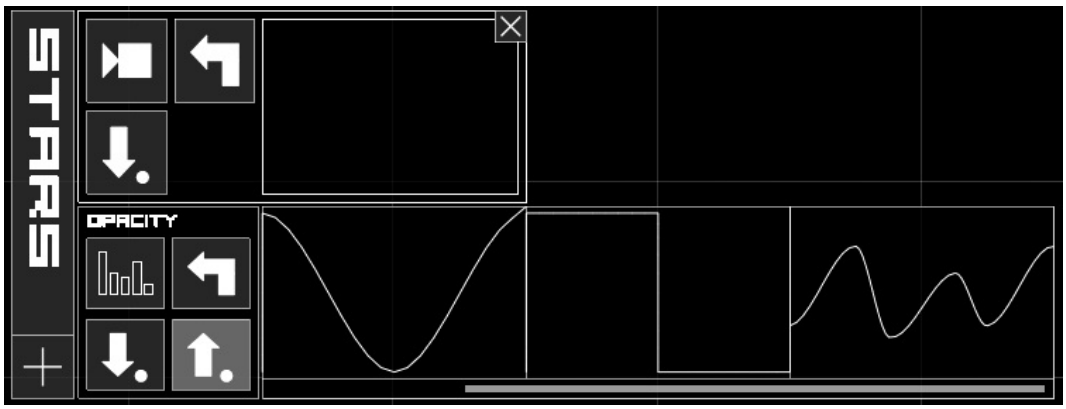

Figure 32: Pre-set retrieval interface

5.6.4.2 Audio-reactive Wave Objects

Andrew noted that on occasions he might require a tighter connection between the visuals and the musical soundtrack of a performance, than would be possible by setting patterns in the spline curves. To achieve this, Andrew suggested a mechanism whereby particular frequency bands of an incoming audio track stream (e.g. from a DJ's mixer) could be mapped to parameter values. As a result, Andrew hoped that he might be able to directly associate elements of a track (e.g. a particular snare drum) with a visual.

In response to these ideas, an additional mode was added to the Wave Object, whereby a Fast Fourier Transform is used to divide an audio input signal into a set of frequency bins. The values of these frequency bins are then rendered on the background of the associated Wave Object track. The spline curve can then be used to set an envelope that defines the frequency ranges to which the parameter responds (Figure 33). This allows for the spline-based interaction of the Waves Object to be leveraged in the provision of this additional audio-reactive mode of controlling visuals.

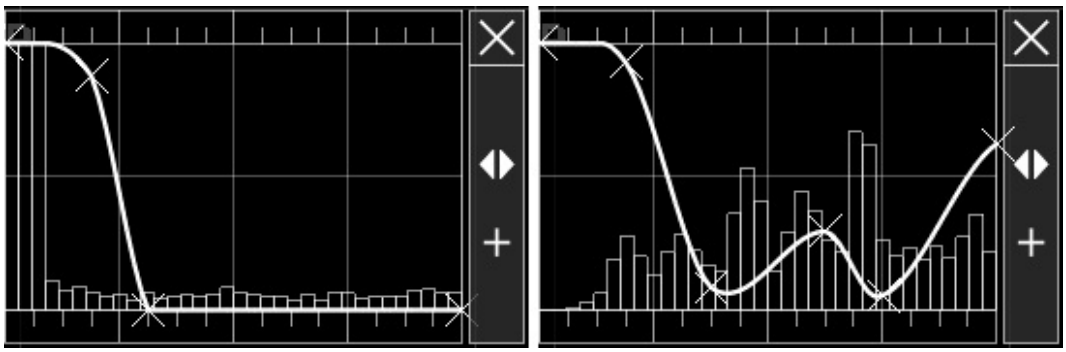

Figure 33: Audio-reactive Wave Objects (left) reacting to bass and (right) reacting to a more complex frequency spectrum

5.7 Evaluation

In the final stage of the design process presented in this chapter, Andrew collaborated with another VJ (Elliot) to create a performance using Waves. By engaging with Andrew as he incorporated Waves into his practice, it was hoped that the relationship between the design and the practice it was designed in response to could be explored and understood.

Andrew initiated the development of this Waves performance by collating a range of images that illustrated both the visual aesthetic and forms of manipulation he imagined achieving when performing with Waves (Figure 34). Andrew selected images that matched the aesthetic of the GUI; this would turn out to further integrate the interface into the visual elements of performance. With programming assistance provided by myself, the ideas posed by these images were developed into a catalogue of visuals, which formed the basis of the performance. Concurrently, Andrew created a soundtrack to accompany the piece, with tracks selected to match the aesthetic of individual visuals. Over the course of many hours of rehearsal, these elements were brought together to form a complete piece,

which was delivered by Andrew and his collaborator alongside a range of other audio-visual performances at a pay-to-enter public event.

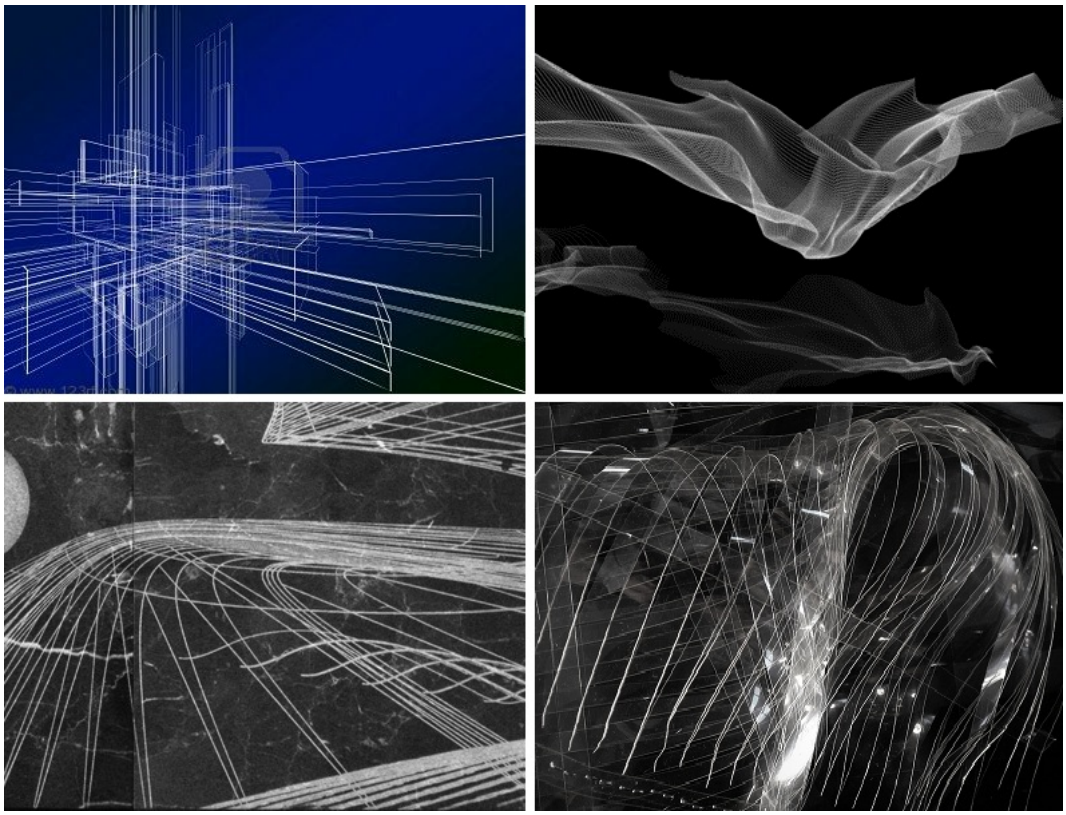

Figure 34: Images illustrating the imagined aesthetic

As many of the design goals of Waves related to the audience's experience of Andrew's practice, a set of semi-structured interviews (approximately 45 minutes) were conducted with selected audience members in the two weeks following the performance, in order to ascertain their response. Three audience members[1], Richard (aged 51) a media arts student, Kate (aged 27) a play therapist, and Tom (aged 26) a musician who was also performing at the event were recruited to take part in these interviews. This recruitment involved sending an email to the mailing lists that were used to advertise the event.

On the night of the performance, each of the spectators was met separately in the hours before the show and told that they were to watch a short VJ performance. At this time they were presented with four questions printed on a piece of paper (What do you think of the performance? How does it compare to anything like this that you have seen before? Do any particular bits stand out? Do

[1] Fictional names are used to maintain the spectators' anonymity.

any of the performers' actions catch your attention?), which they were asked to consider while watching the performance. It was hoped that by asking simple open questions the spectators might be stimulated to be reflective on the kinds of issues underpinning the design of Waves, without their experiences of the performance being biased. The spectators were given free entry to the event and two free drinks as compensation for their time.

To elicit Andrew's experiences of creating and delivering a performance using Waves, two semi-structured interviews (approximately 45 minutes each) were conducted following the performance. The first interview, which was conducted in the week following the performance, addressed the general experience of performing with Waves and included questions that sought to uncover the relationship between both the design as a whole and its individual components, and the issues of Andrew's practice that it was designed in response to. In the second interview, additional questions were posed that attempted to address points raised in the first interview in more depth. Additionally, Andrew was shown an initial anonymised account of the spectators' responses to the performance. It was hoped that by showing Andrew the four spectators' responses to his and Elliot's performance, he might be inspired to reflect upon his own interpretation of the performer-audience relationship, and general audience experience, of a Waves performance.

Questioning the study participants about their experiences of the Waves performance would prove to be a challenging act. Methods that might elicit insight during the moment of performance, such as Experience Sampling (Csikszentmihalyi and Larson, 1983) or Contextual Inquiry (Wixon, Holtzblatt and Knox, 1990), were disregarded as it was expected that such methods might prevent participants from having an authentic experience of the performance. Such methods were believed to be particularly problematic in the case of the performers, where any attempts by researchers to pose questions during the course of the show would obviously be an unacceptable intrusion. However, it was also feared that participants might not be able to reflect adequately upon the experience of the performance when questioned out of its immediate context.

In response to these concerns, a method was utilised, based upon the notion of video-reflection (Raingruber, 2003), whereby the interviewees were shown a

video prompt that served as a reminder of the performance. Two different video prompts were created from footage of the performance: one for the spectators, which showed a shot of the performance from the audience's perspective; and another for Andrew, which showed both the audience view[1] and also a close-up shot of Andrew's (and his collaborator Elliot's) interactions with the interface (Figure 35).

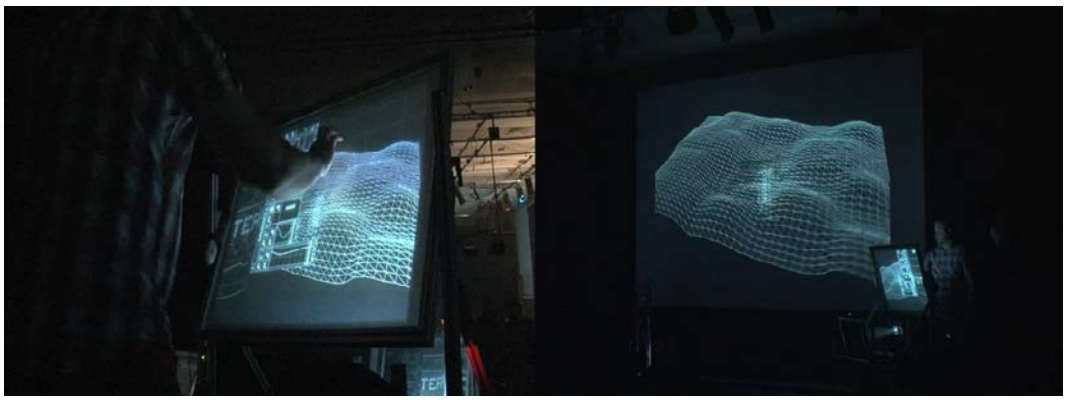

Figure 35: The video prompt shown to the performer

IPA was used to analyse the data resulting from these post-performance interviews. IPA was chosen again due to the method's focus on individual experience, this time as a means to uncover Andrew's and the spectators' potentially differing experiences of the performance. Transcripts of the interviews with Andrew and those with the spectators differed substantially in structure and content. To address this, the standard application of IPA (Section 5.5) was modified by first analysing each data set separately to produce two individual collections of themes. The two collections were then compared (for connections and relations) and, as a result, a final set of themes was produced.

5.7.1 Balancing the Focus on Salient Interaction

Comments from the spectators suggested that the Waves design was successful in making the performers' (Andrew and his collaborator) actions salient, yet elusive and enchanting. There was a consensus that while the performers' contribution was evident, it was not fully understood. Kate thought the performers' "focus" and

[1] Due to one of the video cameras being configured incorrectly during the evaluation, the audience view for the prompts was shot with a noticeably low frame rate. However, it was found that the prompt still acted as a sufficient reminder of the performance for both Andrew and the spectators.

“cognitive involvement” were apparent while both Richard and Tom believed that there was a degree of improvisation taking place. Kate and Tom sensed that the performers were being creative; Tom thought being able to acknowledge that a creative process is taking place is more important than understanding it. Despite the specifics of the performers' actions being unclear, the spectators were positive in their remarks about what was described as the “open” nature of the performance. The spectators described how they particularly enjoyed speculating about the exact nature and consequences of the performers' interactions with the interface.

Because of the quality of salience imbued in our design, the performers' interactions became a central focus of interest. Upon seeing the proportion of discussion that focused upon the spectators' attention and intrigue about the performers' actions, Andrew raised concerns that bringing the mode of control to the forefront of performance might actually distract from its essence, which he saw as the visuals. He stated that a careful balance must be struck that prevents a piece from becoming “too concentrated on the technical”. However, when reflecting upon his personal experiences of attending others' performances he questioned whether such concerns were unfounded, arguing that curiosity about a performer’s actions is a natural and enjoyable phenomenon of all performance. By breaking down a “technical barrier” that traditionally exists between audiences and performers, Waves was said to make such experiences of enchantment and inquisition more central and, therefore, more “comfortable” aspects of the performance.

5.7.2 Personal and Interrelated Experiences of Performance

The spectators' accounts of the performance each highlighted idiosyncrasies of experience. Richard particularly enjoyed observing the communication between performers while Tom valued aspects of the design that provided “insight into the process behind the sort of finished product”. Kate stated that, because of the open design of Waves, she felt the audience participated as a collective in an experience of curiosity and wonder about the performers' actions. In this respect, the Waves performance was said to be more participatory than an interactive piece shown later in the event, as the lack of explicit interaction between performer and

audience meant that no one was excluded and therefore the whole audience could participate on an equal footing.

Kate's account is particularly interesting, as her experience of participation appeared co-constructed (McCarthy and Wright, 2004) through conversations about the performers' actions with other curious spectators. Furthermore, as Richard and Tom did not report a similar experience, it is possible that those Kate shared this experience with those that might not have experienced it. Here parallels can be drawn with the notion of witting and unwitting participation (Sheridan, Dix, Lock. and Bayliss, 2004).

Accordingly, the personal and interrelated nature of the experience of a performance is highlighted. This suggests that approaches to design should not only consider the singular relationship between performer and audience but also should draw on frameworks, such as the tripartite model of performance (Sheridan, Bryan-Kinns and Bayliss, 2007), which consider the complex interrelations between all those central to the co-construction of experience, within the performance environment.

5.7.3 Bases for Generative Manipulation

Andrew said that he felt Waves achieved the goal of "being about generative graphics and control and being able to manipulate real graphical elements" as he was given the ability "to almost draw and literally control things completely live". As a result, he stated a desire to explore the "more real graphical, real-time visual aesthetic" posed by Waves in the future evolution of his practice. Furthermore, when viewing the prompt, Andrew expressed his satisfaction with the resulting visual aesthetic; highlighting the fact that despite the increased scope for complex and creative manipulation of visuals during the moment of performance, he still was able to produce visuals that met the high standards of his practice.

When designing for a sense of generative manipulation in Waves, concerns were raised about increasing the level of creativity during the moment of performance, as it was thought that this might result in the performer becoming overloaded with functionality; the likely reason that separate tools for composition and performance exist in the first place. Andrew also shared this concern, but

suggested that select elements of the Waves design made the generative control manageable, by providing a basis for manipulation.

Andrew thought that a performance based purely on the manipulation of spline curves to set parameter values might prove too complex, as "you'd have too many parameters to try and manipulate at once". The audio-reactive mode of Wave Objects was said to circumvent this problem, as a basic level of activity for a visual could be attained instantly; therefore, easing his workload during performance. However, Andrew stated that if the audio-reactive mode was not coupled with the more detailed control offered by the original mode then the resulting visuals might become "quite dull".

Additionally, the pre-set spline curves were said to provide a starting point from which Andrew could experiment and improvise. The performance was described as being structured around pre-sets, which were created to initiate particular stages of the performance. These would then be experimented with and built upon during the show. Pre-sets also played a role in reassuring Andrew when improvising, as they provided a fall-back in case he were to become overwhelmed, lost or make a mistake.

Andrew remarked that the balance between manageability of control and the potential for live creation was "bob on". Key to the maintenance of this balance was the avoidance of control becoming "predefined" and consequently limiting. This can be related to the notion of progressive disclosure (Johnson, et al., 1989). However, it is important to stress how the interaction afforded by Waves allows the performer to flow between basic control and more complex manipulation as both are achieved in the same interaction context of the spline curve, rather than on a further screen or using a different interaction technique.

5.7.4 Data vs. Form-centric Interaction with a Medium

The approach to designing medium-like interaction in Waves was based upon a mapping between the visual form of the Wave Object's spline curves and the underlying parameters of the visuals. In this way, it was hoped that Andrew would both sense the manipulation possibilities of the visuals and respond as part of a tight and dialogical feedback-loop. This form of interaction was referred to as data-centric interaction with a medium.

While Andrew said that this method of interaction with the underlying parametric data of the visuals was "quite intuitive and the best way of doing it", he stated that there were times during the performance where he wished for more literal and direct interaction with the rendered form of the visuals. He asked whether the design might "miss a trick, or miss something that we'd set out to do right at the start, [which] was physically being able to touch the visuals on the screen". In response to this desire, he proposed design alterations such as adding handles onto the form of the visuals so they could be directly grappled with as if they were physical objects.

Andrew's comments suggest a shortcoming in the data-centric design approach to medium-like interaction, in cases where the performer constructs a mental model of interaction possibilities in terms of gestural manipulations that could be made directly to the rendered form of a visual. An alternative might be to afford more literal, form-centric, interaction; for example, by utilizing techniques for direct multi-touch interaction with 3D models, such as those proposed by Riesman, Davidson and Han (2009).

However, Andrew concluded that he would not wish the design of Waves to be altered in this respect, stating that if a more literal mechanism of control was utilized to manipulate the parameters of a visual, interaction with the more abstract visuals, such as those based upon algorithmic generation, might become impossible. Interestingly, Andrew commented that these more abstract visuals, which suited the data-centric interaction paradigm, were the most satisfying to interact with as direct control over a form might have quickly become boring; therefore, highlighting the positive experience had when interacting with Waves's data-centric interaction paradigm in the context of appropriate visuals.

5.8 Reflection on the Design

One of the three main aims of the research presented in this thesis was to develop innovative interaction techniques and interfaces in response to the practices of live performers. In this section, Waves is contrasted with a number of previously designed interfaces that respond to issues similar to those presented by Andrew's practice, in order to highlight the novelty of its design.

One of the princip aims of the Waves design was to create an interface that would make the performer's interactions visible and apparent to the audience yet not transparent, literal or descriptive. As a result, it was intended that the design would evoke an experience of enchantment amongst audience members. A number of previous designs have explored how VJs' interactions with their tools can be made more visible to an audience. Wearable sensors (Zingerle and Freeman, 2011), motion tracking (Banerjee, Burstyn, Girouard and Vertegaal, 2011) and sensors embedded in physical objects (Tokuhisa, Iwata and Inakage, 2007) have all been used to allow VJs to manipulate visuals using visually apparent physical gestures. While it has been reported that such *gestural interfaces* can make a VJ's interactions more visible to an audience, such interfaces can be seen to often rely on simple mappings between gesture and the control of visuals that do not offer the complexity and variation of control required of Andrew's desires for Generative Manipulation and Medium-like interaction.

An alternative approach to amplifying a VJ's interactions during a live performance, which the Waves design builds upon, is to make the GUI of a VJ's tools visible to the audience. Tabletop interfaces (Taylor, et al., 2009) and double-sided interactive surfaces similar to the one used in the Waves design (Lew, 2004) have been used to allow audience members to see the GUI of a VJ's tools during performance. This approach of revealing the GUI to the audience has been shown, in previous work and during the evaluation of Waves, to make the performer's actions visible to the audience, while still allowing the VJ to have the complex and varied control offered by a fully functional VJ tool.

Waves extends this previous work by exploring how placing the GUI in view of the audience can not only make a VJ's interactions more visible to an audience, but also how the interface that is shown to the audience can be carefully designed to make the performer's actions apparent yet not descriptive and literal, and, consequently, evoke a sense of enchantment about his or her interactions. Comments from the audience members interviewed suggest that the design of the Waves interface offered a practical means to facilitate this kind of visible yet enchanting interaction. Additionally, the Waves design extends this previous work by exploring how the interface, when shown to an audience, can become a core visual component of a VJ performance, rather than an ancillary element that is

occasionally viewed to understand the performer's actions. The design of Waves highlighted two ways that this could be achieved: matching the aesthetic of the interface with the VJ's visuals and designing interaction techniques that are visually interesting and compelling in addition to being functional.

Another central aim of the Waves design was to allow Andrew to create and expressively manipulate visual content *from scratch* (or as close to as possible) during the moment of performance. This was achieved by providing Andrew with a means to manipulate the parameters of CGI during live performance. Of course, Andrew and I were not the first to explore the use of generative CGI during a live VJ performance. Rather, the use of generative CGI in VJ practice and other forms of audio-visual performance has a rich history, with examples of performances based upon generative computer graphics going back over 40 years (see Boden and Edmonds, 2010). Additionally, a number of interfaces have been developed that allow VJs to manipulate generative visuals, which range from those based upon a traditional desktop/laptop interaction paradigm (e.g. Aestesis, 2013) to the parameterisation of generative visuals using live audio (Cooke, 2009) or video (Jacquemin, 2008) input streams.

The Waves design builds upon previous work that has explored the design of interfaces to control generative visuals during live performance. The design offers an alternative form of interaction that combines multi-touch with the use of spline curves to allow a VJ to control both the parameters of generative visuals over time and to associate different frequencies from an audio input stream with a visual's parameters. Andrew's experiences of using this form of interaction during performance suggest that it offered him a powerful, yet practical, means to manipulate generative visuals live. Moreover, it is argued that this form of interaction extends previous work by offering a way to manipulate generative visuals that is also imbued with performative qualities that resulted from designing in response to Andrew's desires for Salient Interaction and the Coalescing of Interface and Performance.

The final aim of the Waves design was to provide Andrew with a means of manipulating visuals that shared qualities with McCullough's (1998) notion of a medium. In order to provide Andrew with such medium-like interaction, while also allowing him to manipulate abstract and dynamically changing visuals (such as

those based upon algorithmic generation), a scheme was proposed whereby visuals were controlled through the manipulation of parameters rather than literal interaction with their form. Andrew and I were not the first to suggest that a performer's interaction with CGI should be mediated through abstract parameters rather than the literal manipulation of form. For instance, in the Lightwork Performance Bowers, Hellström and Jää-Aro (1998) allowed performers to interact with a 3D virtual world by manipulating algorithms that controlled that world, rather than through literal interactions with the entities within it. This form of interaction with the underlying media of the Lightwork performance was referred to as being "algorithmically mediated" and can be seen to have strong similarities with the notions of Data-Centric Interaction with a Medium explored during the design of Waves.

Despite these similarities, it is argued that the design of Waves still makes a novel contribution, as it demonstrates a concrete and practical means by which designs can realise both medium-like and algorithmically mediated interaction in the context of VJ practice. Furthermore, it is argued the design makes a valuable contribution by showing how medium-like interaction can be realised in a way that is also in keeping with the other design considerations derived from Andrew's practice, such as the desires for Salient Interaction or Generative Manipulation. This final point is crucial in understanding the novelty of the Waves design in general. While there are similarities between the way that Waves responds to the individual issues of Andrew's practice and previous designs, it is argued that the core novelty of the design lies in the contribution of a concrete way that all four of the issues identified in Andrew's practice can be addressed holistically in a single design.

5.9 Reflection on the Design Process

The idiographic approach presented in this chapter sought to facilitate the proposal of an innovative design in response to the relationship between potentially tacit issues of live performance and an individual's practice. To this end, particular attention was paid to exploring a live performer's creative ideas about how design should respond to his practice. In the following sections, a number of

reflections upon my experience of applying this approach, with respect to these goals, are presented.

5.9.1 Adopting an Idiographic Perspective to Wicked Problems

Throughout this thesis, it has been shown that issues affecting design for live performance are subtle, complex and varied in their instantiation across different genres and individual artists' practices. Consequently, it has been argued that a holistic approach to design for live performance should be taken, which considers issues as they are lived and felt in individual artists and audiences' experiences of live performance. By focusing on just one artist's practice, it was found that such an idiosyncratic focus on lived and felt experience could be achieved during the design of interactive technology for live performance.

Andrew's practice provided a unique and concrete perspective on key issues of live performance. For instance, notions of saliency and the coalescing of interface and performance highlighted novel and concrete angles on more abstract issues related to the performer's presence on stage. These individual perspectives offered tangible insights that motivated and guided the design process and, as a result, were found to be essential for the establishment of a creative and dialogical design process in response to Andrew's practice. In the initial stages of ideation Andrew's perspective presented palpable aspirations and challenges that preliminary design concepts could be proposed and developed in response to. Furthermore, as these preliminary ideas were worked into prototypes, Andrew's tangible preferences, desires and concerns could be used to formulate, evaluate and select possible developments of the design.

In this way, the individual focus offered by the idiographic approach stood out as being a particularly compelling way to address wicked problems in design. Rittel and Webber (1973) originally proposed the concept of wicked problems to describe social challenges that, due to their complex and subjective nature, could not be addressed using the tools of the natural sciences or engineering. Subsequently, the term has been borrowed to refer to similarly intricate and idiosyncratic challenges faced by interaction designers (Zimmerman, Forlizzi and Evenson, 2007; Gaver, 2012). Live performance stands out as an intrinsically wicked design space, as the key issues affecting the experience of live performance

(e.g. the artist's presence in the performance space) are characteristically entwined with the individual practices of performers and their audiences.

By focusing on just one person's lived experience of these issues, it was found that the idiographic approach demarcated a concrete space for the interaction designer to work in. Consequently, the wicked problem of engaging many subjective and contrasting views and experiences in design was replaced with the more tractable challenge of proposing a bespoke design in response to a single individual's concrete perspectives on issues. In this way, the idiographic approach was seen to support the designer in responding to issues of live performance as lived and felt, while avoiding the abstraction and objectification of the design space (the commonly adopted alternative response to this challenge) that can result in the subjective essence of experience being "designed away" (Boehner, Sengers and Warner, 2008).

5.9.2 Idiographic Design as a Participatory Inquiry

The understanding of Andrew's practice that underpinned the design of Waves was initially developed during the interview sessions and subsequent qualitative analysis. The IPA process was found to afford a particularly reflective form of inquiry into the issues and creative views discussed during the interviews, which was crucial to the development of the initial Waves design. However, the design was not a straightforward reification of the themes resulting from this qualitative analysis. Rather, it was found that Waves, and the understandings upon which it was based, were constantly evolved throughout the design process.

Fallman (2007) observed that designs "act as vehicles through which HCI researchers' ideas materialize and take on concrete form". Similarly, it was found that the development of early prototypes provided a concrete representation of particular aspects of my interpretation of the relationship between Andrew's practice and design. Subsequently, initial design ideas, and the understandings of Andrew's practice that underpinned them, were questioned and developed in a way that was not possible in the earlier and more abstract interview discussion. For example, preliminary plans to adopt physics-based interaction (i.e. based upon a simple physical model of a piece of string) with the spline curves, in order to provide a sense of physical grappling with the underlying media of performance,

were abandoned as it was realised that such a scheme would not afford the precise control required of Andrew's practice. As a result, the focus of designing for medium-like interaction shifted to explore the abstract qualities of direct interaction with a material (e.g. precision, immediacy of response) rather than the physicality of the relationship between performer, tools and materials. In such situations, it was found that the design and process of designing, like Gaver's workbooks (2011), revealed a space of possible design ideas that could be either directly incorporated into Waves or acted as inspiration and guidance for the reformulation of the understanding of Andrew's practice.

The role of design as a reflective activity was particularly pertinent during the later more participatory stages of the design process. By giving tangible form to my interpretation of Andrew's practice, the Waves prototype inspired in-depth discussions with Andrew about the nature of the issues the design sought to address. These discussions further developed my interpretations of Andrew's practice and consequently guided the development of the design. Moreover, by inviting Andrew to partake in the creative activity of designing, it was found that he was pushed to reflect upon the relationship between the design and issues of his practice. Consequently, it was found that Andrew's involvement in the iteration of the design grounded a kind of participatory inquiry, which stimulated design-focused discussion and reflection.

It is hypothesised that due to the inherently involved and dialogical nature of the knowledge underpinning design (Schön, 1991, p. 79) these participatory aspects of the design process will have led to insight into Andrew's creative views about the design, which are expected to have changed and evolved as a consequence of his involvement in the design process. Consequently, it is argued that insight will have been uncovered because of Andrew's participation in the design process, which simply could not have been elicited during the detached context of the interview sessions.

Furthermore, Andrew's participation in the design process was found to lead to a number of concrete ideas that were directly incorporated into the iteration of the design. It is expected that the kind of direct contribution to the design afforded by Andrew's involvement in the later stages of the process will have led to the iteration of the design in response to qualities of Andrew's practice

that might have been missed in the earlier interview sessions due to their tacit nature. By allowing Andrew to suggest direct alterations to the design, it is expected that design decisions will have been formulated in immediate response to his own personal and tacit knowledge of practice, rather than through their possibly inadequate articulation to me as an external designer.

5.9.3 Innovation through Idiographic Design

The Waves design comprises a number of innovative forms of interaction. Many of these innovations were inspired by subtle and delicate variations upon common issues affecting live performers, which were discovered through the close idiographic engagement with Andrew's practice.

For example, many previous designs have sought to address the degraded presence of the live performer, which results from using digital technology during a show (i.e. the laptop-performer problem). Many of such design responses have focused upon simply amplifying the prominence and legibility of the performer's actions (e.g. Lew, 2004; SmithsonMartin Inc., 2012). By responding to Andrew's creative aspiration for an interface that subtly balanced legibility and mystique in order to evoke a particular experience of enchantment amongst audience members, the gestural, yet abstract, spline-based interaction of the Waves design was developed, which represents a significant deviation from previous solutions to this challenge.

In another example, intimate and physically embodied interaction with digital technology has been highlighted as a vital quality of interaction in both the studies conducted in this thesis and in the literature of electronic music performance (e.g. Magnusson, 2006; Bertelsen, Breinbjerg and Pold, 2007). By exploring how this kind of interaction could be afforded in the specific context of Andrew's practice, the notion of data-centric interaction with a medium was proposed, which enabled such physically embodied interaction to be offered in the context of abstract visual content (i.e. visuals for which a physical, form-centric interaction paradigm would not make sense).

The forms of interaction presented in these examples, each demonstrate how in-depth and detailed insight into an individual's practice inspired innovative design with regard to issues faced in the wider context of VJ practice. It is argued,

therefore, that the idiographic approach offers a valuable mechanism to inspire innovative design by allowing the designer to consider the individual and subjective perspectives on issues, which might not be found during a more abstract response to multiple artists' practices.

5.9.4 Is Idiographic Design a Practical Approach?

In this chapter, it has been shown that an idiographic approach can support interaction designers in responding to key issues of live performance, as they are manifest in the lived and felt experiences of individual artists' practices. Consequently, it is argued that idiographic design should be recognised as an appropriate and valuable interaction design strategy for live performance. However, idiographic design strategies face criticism in terms of two key limitations, which might prevent their widespread adoption by interaction design practitioners. These potential shortcomings relate to the generalisability of designs forged from an individual's perspective and the timescale required to conduct the in-depth and detailed user-engagement required of the approach. In this section, the significance of these two concerns is evaluated.

Concerns about the generalisability of idiographically-designed artefacts, stem from the intrinsically bespoke nature of the process. Responding to the specific and idiosyncratic aspirations and practices of one artist was shown to afford a holistic engagement with issues as lived and felt. However, the in-depth engagement of an idiographic design stance comes with the risk of proposing a design that is only appropriate and fulfilling to the immediate design subject. If this were the case, idiographic design might not prove to be a commercially viable strategy for most practitioners.

However, reflection upon the design of Waves suggests that interactive technologies resulting from idiographic approaches might actually be more generalisable than first expected. Waves can be seen to address issues shared across both VJ practice and the wider spectrum of technology-mediated live performance. Andrew's individual perspective was not found to be valuable due to the unique challenges it posed, but rather for offering detailed and concrete instantiations of collective issues that could be directly engaged in design. Consequently, it is expected that the Waves design might not be alien to the wider

population of VJs, but may actually resonate with the many performers who share similar concerns to Andrew.

In this respect, parallels might be drawn between idiographic design and Holmquist's (2004) notion of "user-driven innovation". When conducting user-driven innovation, the designer seeks out "extreme users" who might provide unique and inspiring perspectives on issues relevant to the practices of a broader user group. For example, in one case of user-driven innovation the practice of Lomography (a niche genre of photography) was explored to provide a novel and inspiring perspective from which the design of an innovative digital camera for more general use could be proposed (Ljundblad and Holmquist, 2007).

When viewed through this lens, idiographic design stands out as a mechanism through which a detailed examination of the relationship between one artist's aspirations and key issues of live performance might provide inspiration for design responses that are valuable to a wider body of performers. However, it is argued that idiographic design is distinct from user-driven innovation, as engagement with an individual person's perspective is not sought primarily for reasons of innovation. Rather, in idiographic design the consideration of an individual's perspective is an essential mechanism that allows the interaction designer to consider the kinds of complex, subtle and embodied issues that underpin the experience of live performance, which might be overlooked by an alternative nomothetic design stance.

One of the most beneficial characteristics of the idiographic approach employed in this chapter was the intimate relationship developed between artist and designer. This kind of in-depth and longitudinal engagement was found to be vital when attempting to understand, empathise and subsequently design in response to the experiences and creative aspirations of Andrew's practice. However, given the limited timescales and resources interaction design practitioners are often given to develop designs (Stolterman, 2008) it might be argued that, for many, the development of the kinds of close relationships required of idiographic design might not be viable.

The experience of employing the idiographic approach during the design of Waves, would suggest that such concerns might be unfounded. When likened to recent experiences of conducting more traditional human-centred design work (a

design-led study of the photography practices of 15 children with additional needs and their teacher) it was found that the contact time between designers and users was not substantially different. As it would be expected, however, devoting this similar period to engaging with just one person's practice led to the far superior depth of individual engagement exhibited during the Waves design process. Consequently, it is argued that idiographic approaches to design should not be discounted by interaction design practitioners due to the longitudinal engagement with the artists required. Rather, idiographic design should be viewed as an expedient means for interaction designers to utilise the limited time they might have available (i.e. by focusing on one user rather than many) to facilitate the kinds of in-depth, detailed and idiosyncratic engagement essential for interaction design that seeks to respond to the lived and felt experience of live performance.

5.10 Conclusion

In this chapter, the design and evaluation of Waves, a multi-touch interface for VJing was presented. An idiographic design approach was employed, which sought to engage issues of live performance as they were lived and experienced in an individual live performer's practice. This design approach was configured to engage the individual performer in the design process; therefore, allowing for insight into his creative views to be fed directly into the evolving design response. The evaluation of the Waves system in a genuine performance demonstrated how the idiographic consideration of a live performer's practice in design, led to the proposal of an innovative design that responded appropriately to a number of subtle qualities and issues underpinning that individual's practice.

The design resulting from this idiographic engagement with VJ practice, Waves, is imbued with a range of innovative forms of interaction. It is envisaged that these forms of interaction will provide valuable inspiration and guidance to interaction designers wishing to design interfaces for VJ practice and potentially related domains of technology-mediated live performance.

Reflection on the design of Waves revealed a number of compelling qualities of the idiographic approach. Of particular interest was the in-depth dialogue between designer and performer that arose during Andrew's participation in the later stages of the design process. It is argued, therefore, that

those doing idiographic design for live performance, or in other contexts, might benefit from more closely involving the subject in the actual process of designing. Finally, it was claimed that concerns about the generalisability of designs resulting from an idiographic approach might be unfounded. However, it is believed that further research might be required to explore the value of idiographic designs, such as Waves, beyond the practice of the immediate design subject.

CHAPTER 6

Designing Physics Synth

6.1 Introduction

In the previous chapter, an idiographic approach to the design of interactive technology for live performance was developed during the design of Waves, a multi-touch interactive surface for VJing. By focusing on one individual VJ's subjective account of their practice, this approach was found to support the designer in proposing a concrete design response to the kinds of subtle and complex issues that have been shown to underpin the experience of live performance.

In this chapter, the design and evaluation of Physics Synth, a multi-touch interface for digital music performance, is presented. The idiographic approach employed in the design of Physics Synth was configured to leverage the kind of valuable design insight that was shown to have resulted from Andrew's increased participation in the later stages of the Waves design process. It was found that as Andrew was invited to participate in the iteration of Waves, in-depth discussion of the relationship between issues of his practice and the evolving design were fostered. These discussions inspired a number of creative design ideas that were incorporated into the final Waves interface. In response to these positive experiences of the live performer's participation in the Waves design process, a *more participatory* slant on idiographic design is developed in this chapter, which involves the co-design of an interactive technology in response to an individual artist's practice.

An evaluation of Physics Synth with two additional musicians (who were not involved in the design process) suggests that the Physics Synth design will not only prove relevant and fulfilling to the person it was designed for, but to a wider

group of electronic musicians. Consequently, it is argued that the design, and the innovative forms of interaction that it is comprised of, may offer valuable inspiration and insight to interaction designers addressing live electronic music and other related domains of technology-mediated performance. Finally, reflection on the design process further explores the values of using an idiographic approach when designing for live performance, with a particular focus on the consequences of increasing the performer's participation in the design process.

6.2 Co-Design for an Individual's Practice

In the previous chapter, it was found that inviting Andrew's participation in the iterative development of Waves uncovered a range of creative design ideas and insight, which proved to be instrumental in shaping the final interface. Inspired by the positive consequences of Andrew's relatively brief participation in the design process, the idiographic approach adopted in this chapter was adapted to be *more participatory*. The live performer was invited to participate in the entire process of designing, from the formulation of initial design ideas and concepts to the development and iteration of the final designed artefact. In this way, the idiographic design approach became a collaborative effort to co-design[1] a response to the issues affecting the live performer's practice.

The design process focused upon the practice of Paul, a composer and live performer of experimental and improvisational electronic music. Paul had a background as a turntablist and scratch DJ[2]. However, at the time of the study, he was in the process of exploring how this practice might be developed to incorporate further elements of digital music performance. In this respect, he wished for tools or instruments that exploited the opportunities posed by digital music performance, while retaining the properties and characteristics of the turntable that were definitive of his existing practice. Paul also featured in the study of VJs presented in Chapter 4. However, by the time of the design process reported in this chapter he had returned to an almost exclusively musical practice.

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[1] The term co-design is used in line with Sanders and Stappers's (2008) definition of "designers and people not trained in design working together in the design and development process".

[2] In the years preceding the study, Paul's practice had been conducted in an academic context while completing a PhD in Music.

The process of engagement with Paul commenced with three semi-structured interviews. These interview sessions followed a similar format to those described in Section 5.4. An interview script was based upon topics uncovered during the study of VJ practice in Chapter 4 and the Waves design process. It was anticipated that the concerns of both VJs and electronic musicians would be sufficiently alike for these themes to form the basis of a relevant and probing interview. Moreover, it was hoped that by basing the interviews upon a set of issues gathered through a study of VJ practice, their potential generalisability might be explored. As with the approach presented in the previous chapter, a number of subtle configurations were made to the semi-structured interview process in order to frame discussion in terms of how design should respond to Paul's practice.

It was hoped that by commencing the design process with such interviews, Paul and I might be afforded the opportunity to discuss, and subsequently establish shared understandings of, the key issues of his practice and their potential relationship with design. In this way, it was hoped that the interviews would extend beyond a fact-finding exercise conducted by the designer (as they were framed in the previous chapter). Instead, it was intended that the sessions would inspire reflective design-led discussion of the issues affecting Paul's practice, which would lay the groundwork for a shared understanding upon which an initial co-design could be based.

Following these sessions, an IPA was conducted on the transcribed interview data. This analysis followed a similar approach to that described in Section 5.5. While inviting Paul to collaborate in this analysis process might have fostered further co-reflection on his practice, it was decided that I would analyse the interview data alone. It was intended that by conducting this analysis without Paul's direct involvement, I would be able to develop an interpretation of the issues affecting his practice and their potential relationship with design, which would guide and inspire my contribution to the co-design process. It was anticipated that, like the documentary films and initial Waves design, this interpretation might act as a kind of reflective tool that would inspire conversations between Paul and me about our potentially different

understandings of his practice, during the co-design process. The themes that resulted from this IPA are articulated in the following sections.

6.2.1 Dense Interaction

Paul stressed the importance of tools that did not limit the intricacy, complexity and variation of his interactions. He spoke of the turntable's responsiveness to fine variations in pressure applied by his fingers as he scratches a record. This fine-grained interaction was said to allow subtle "nuances and fluctuations" to be incorporated into his manipulations, subsequently heightening his experience of investing expression into the "quality" of sound. Furthermore, tools that provide an extensive and varied space of manipulation possibilities were said to be essential for his desire to develop skill to potentially "virtuosic" levels. Discussion of his experiences with existing tools for digital music performance suggested that their mode and experience of interaction did not equal the turntable in terms of intricacy and variation. Many were described as adopting a paradigm of "just triggering [loops]" of pre-recorded samples and, therefore, were said to reduce the potential for intricacy and variance of control to a point where the sound produced "is essentially, it's going to be the same each time".

Further discussion suggested that Paul's account should not be interpreted as a call for intricate and varied interaction alone. Digital tools that did offer greater complexity were criticized, as this was often achieved through a multiplicity of isolated controls and functions. For example, Paul commented on a trend amongst leading manufacturers of DJ mixers, to take "the existing paradigm of what a controller should be, and put it in a bigger box". Rather than offering intricate and expressive manipulation, his experiences of such tools were described as overwhelming and unmanageable. Instead, he expressed a desire for interfaces that, like his turntable, would not only afford intricate and varied interaction, but also encapsulate that interaction in detailed manipulations of a simple form: "If you look at it, you'd just think, well, it is just a turntable. But then when you think of what you can do with it".

Paul's comments echo those of Dobrian and Koppelman (2006), who consider the "expressiveness" of musical instruments not only to rely on the provision of complex control, but upon its delivery in an intuitive manner. Perhaps

stronger parallels can be drawn with McCullough's (1998, p. 196) notion of a dense medium – a "material" or "instrumentality" of a craftsperson (in this case Paul), which presents a "continuum of possibilities" where "between any two states there still exists another" – as it captures Paul's apparent desire for complex, yet continuous interaction.

6.2.2 Discovering an Interface's Character

Paul desired tools and instruments with defined and distinguishable character. Acoustic instruments, analogue synthesizers and the "magnetic slime" of FerroSynth[1] (Hook, et al., 2009; Taylor and Hook, 2010) were praised for guiding and inspiring performance due to distinctive qualities that result from the inherent relationship between their basic physical form and sound. In contrast, Paul rejected interfaces that encapsulate a wide and flexible variety of functionality, which he referred to as "box[es] of tricks that will do everything", as such designs might lack the specific function or purpose conducive of a defined character.

To Paul, the role of a tool or instrument's character seemed to extend beyond a source of stimulus or guidance. Rather the character of an instrument was said to act as a conduit for exploration and discovery during performance. In fact, Paul framed many of the improvisational aspects of his practice in terms of exploring the sonic and interactional properties of his tools. For example, he stated that a central motivation for his work with the turntable was exploring the possibilities of "how the hand can actually interact with this object". The ability to search and probe a tool's character instilled his practice with experiences of surprise and creativity, which were most prominent upon the discovery of "extended techniques": methods of playing that vary from those originally intended by the designer (Burtner, 2005).

6.2.3 A Living Interface

The relationship Paul sought with his tools was dialogical rather than dictatorial. Tools for digital music performance were criticized for the typically "one way"

[1] FerroSynth is a tangible user interface for live music performance, designed by Stuart Taylor and me, which Paul was shown videos of as a prompt for discussion during one of the interview sessions.

interaction model they adopt; whereby the software complies with the musician's commands (e.g. to play a sample), yet presents little in terms of a response. Instead, Paul envisaged tools that might actively reply to his interaction to inspire and guide the "trajectory" of his improvised performance.

Feedback, both physical and sonic, was said to be an essential source of dialogue during performance. The role of feedback desired by Paul seemed to extend beyond the confirmation of a musician's actions, previously discussed in the literature (Tanaka, 2000), to embrace the idea that an instrument might give an active and potentially autonomous retort. Paul spoke of how the fragility of the turntable would sometimes lead the needle to skip if he were to be "really rough" when scratching, resulting in an unexpected variation in his performance. Rather than mistakes, such occurrences were described as bringing surprise and discovery to the experience of a performance and offering something he could "work with" to inspire its future direction.

Paul discussed ideas for interfaces that present an ambiguous or partially unpredictable response to an action, which he referred to as having a "life of their own". When considering these ideas, in relation to the possibilities of the digital domain, he envisaged an interface that he might have to struggle to harness during performance: "the ultimate kind of desire really is trying to control this thing that is essentially uncontrollable". However, he warned against the provision of randomized behaviour, as this might sever the legible relationship between his actions and their effect; thus, making the development of skill impossible and potentially rendering his contribution to the performance redundant.

6.2.4 Intervening with Digital Processes

Paul voiced an aspiration for tools that would allow him to "intervene" directly with the underlying computational processes responsible for producing sound in digital music. He felt that existing tools for digital music performance distanced the performer from these essential processes and consequently led to a situation where there is "an algorithm that's kind of doing most of the work" and the musician's ability to manipulate sound during performance (see previous discussion of density) is diminished. Paul's concerns reiterate the findings of Bertelsen Breinbjerg and Pold (2007), who found that electronic musicians prefer

to grapple with and exploit the inner workings of their tools rather than rely exclusively upon the interface metaphors that encapsulate them.

Paul expressed a desire for digital tools that afford a similar "sense of immediacy" to that of acoustic instruments, which he attributed to what Tanaka (2000) has described as their "mechano-acoustical coupling". This aspiration might have been well served by tangible user interfaces (TUIs) that aim to instil a physical relationship between the user and underlying computational media, in this case the processes of digital music (Ishii and Ullmer, 1997; Hornecker and Buur, 2006). However, Paul cautioned against designs that simply replicate the physical and gestural interaction of acoustic instruments as they might stand in opposition to, and therefore not exploit, "what the computer does best which is [...] digital repetition". Consequently, he imagined tools that moved away from literal gestural interaction, while retaining the ability to intervene directly and "immediately" with sound.

6.3 Fostering Participation in Idiographic Design

The co-design of Physics Synth commenced during a series of informal design meetings. During these meetings, Paul and I collaboratively proposed a design in response to our ever-developing understanding of the issues uncovered during the interview sessions. In the first of these meetings, the themes developed during the IPA process were discussed. As a result, a number of initial design ideas were proposed. These designs took the form of very rough sketches, which were used to illustrate and scaffold ideation (e.g. Figure 36). The ideas discussed during this meeting ranged from concepts relating to haptics and actuated input devices to the augmentation of the turntable and Paul's body with accelerometers. One of these sketched design ideas, a synthesiser with a physics-simulation-based interaction paradigm, was selected by Paul and me to form the basis of the proposed design response.

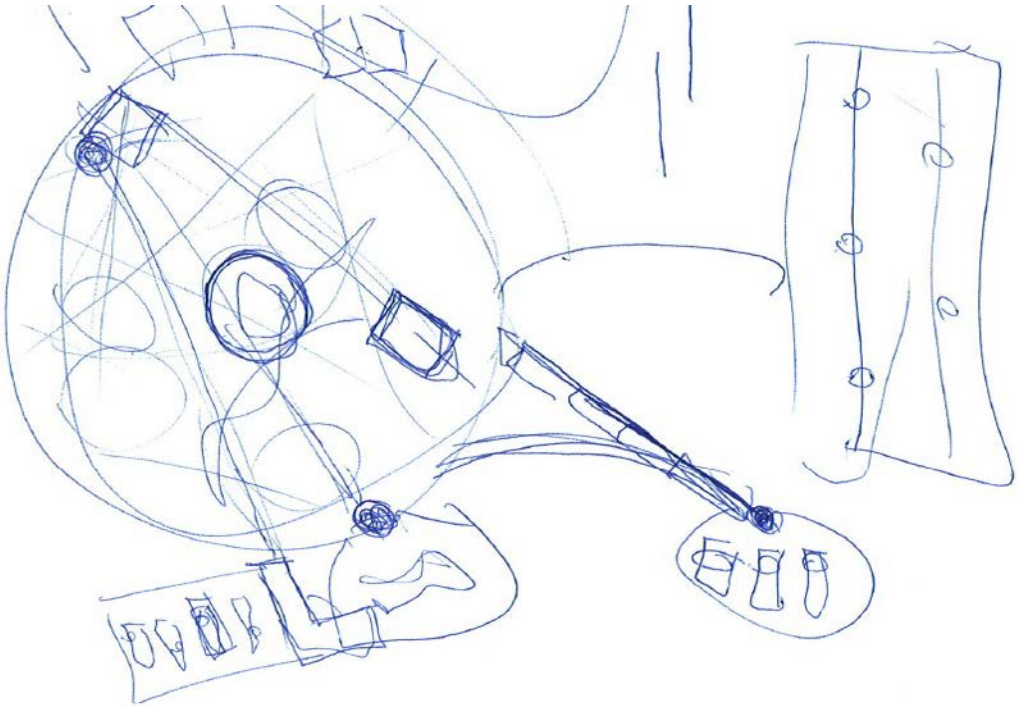

Figure 36: A sketch produced in the second design meeting, which illustrates embryonic ideas for the Physics Synth design

During the remainder of the design meetings, this prototype idea was developed into a fully functional system. At each, Paul was presented with a prototype, which I had developed since the previous meeting. These prototypes, which were of ever-increasing fidelity, were discussed in terms of the issues of Paul's practice uncovered during the interview sessions and, subsequently, concrete plans and ideas were made for their further development. For instance, towards the start of this process, Paul was presented with a simple demonstration of the features of the physics simulation engine, which would eventually be used as the basis for the design. By experimenting with the possibilities posed by the physics engine, Paul and I were able to design an initial set of physics-based interactions, which we felt realised the kind of interaction he desired in his practice. Over time, the design ideas for this initial set of objects went on to become the Simple Objects described in Section 6.4.2.

In the later stages of the design process, once a functioning prototype had been developed, Paul began to experiment with the system between meetings. During this period, design ideas that resulted from Paul's experiences of developing a practice with Physics Synth were developed and incorporated into the evolving interface.

6.4 The Design of Physics Synth

In the following sections, the design that resulted from this collaborative response to Paul's practice is described. The design is presented alongside the co-developed rationale that guided its proposal and development during and between the design meetings.

6.4.1 Using a Physics Engine for Musical Performance

Physics Synth is a multi-touch interface for digital music performance, which utilises the open source physics simulation engine Box2D (Box2D, 2012) as the basis of both sound generation and user interaction. The interface (Figure 37) is comprised of up to eight Worlds, which each represent a distinct physics simulation. Each World has a boundary that may be either square or circle shaped. The performer may add a selection of objects to a World using a press-and-hold gesture; the physics simulation then determines the behaviour of these objects. The size and gravity vector of each world (i.e. the direction objects naturally fall) can be adjusted using a simple menu toward the left-hand side of the interface. Furthermore, Worlds, and the Physics Objects within them, are zoomable using a two-finger pinch gesture.

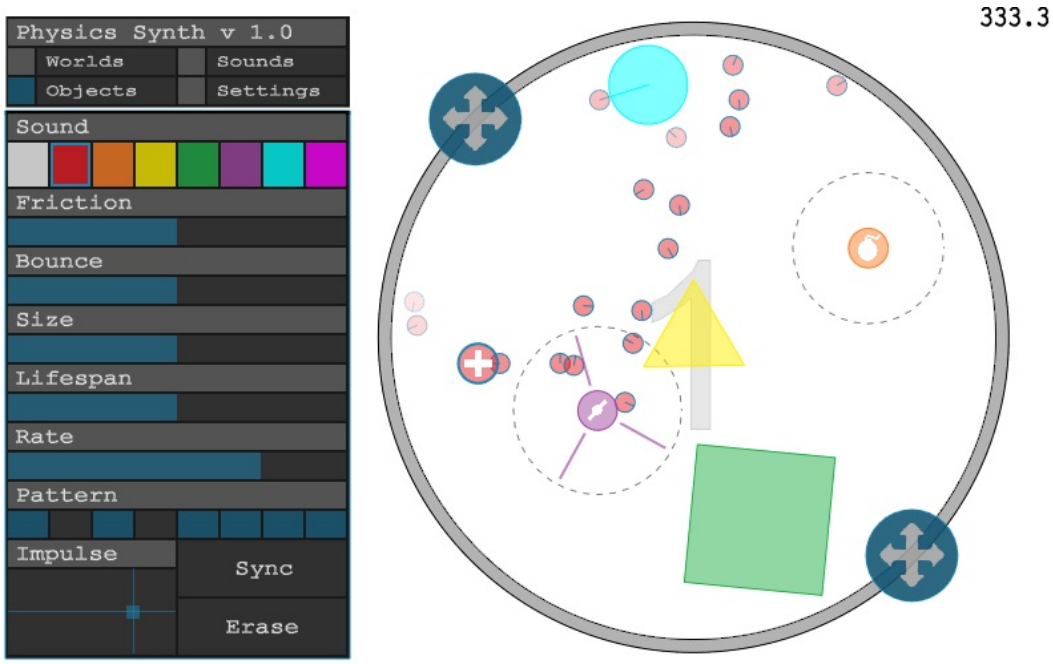

Figure 37: The Physics Synth user-interface showing the menu (left) and a circular World containing various objects (right)

As the objects within a World collide OSC (open sound control) (Wright, 2005) messages are generated, which include a range of parameters describing the physical properties of each collision. These messages can subsequently be used to control sound in an assortment of tools for digital music performance. Physics Synth was programmed in C++, with graphical elements rendered using OpenGL. A tablet PC with a 10.1" capacitive multi-touch screen capable of tracking four simultaneous touch points (Acer Iconia Tab W500) was used as a hardware platform.

6.4.2 Simple Objects

The objects of Physics Synth are divided into two categories, the first of these being Simple Objects. Simple Objects represent basic polygonal forms, such as circles, squares and triangles. Each Simple Object has a set of parameters (size, friction, bounciness) that, in addition to its shape, dictate how it interacts with a World boundary and other objects within the physics simulation. Simple Objects may be placed into a locked state. In this mode, they are immovable within the simulation and consequently may be positioned to act as barriers or buffers to other objects.

The performer can directly interact with Simple Objects using multi-touch gestures. If the performer touches within a World, an area cursor technique (Kabbash and Buxton, 2005) is utilized to select the nearest object that intersects a circular bounding region placed around his or her finger. When selected, a technique similar to that proposed by Agarawala and Balakrishnan (Agarawala and Balakrishnan, 2006) is used to manipulate objects, where a springy joint is connected between the centre of the performer's finger and their initial point of contact on the object (Figure 38). Consequently, as the performer moves their finger the object is pulled to its new position. By using a spring instead of a rigid joint, interaction is afforded that mimics an elastic band being connected between the performer's finger and the object. As a result, objects can be easily flicked and swung around the interface.

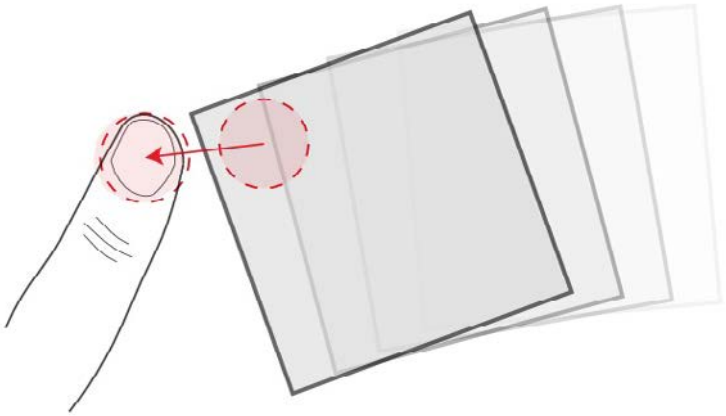

Figure 38: A joint is used to interact with a Simple Object

The choice to utilize a physics simulation engine was at the heart of the design response to Paul's practice. The complexity of state and behaviour that the simulation offered was a crucial element in our attempts to design for the notion of dense interaction. Simple Objects can move and collide in an extremely wide variety of different ways within a World. Each collision has a set of intricate physical features, such as force or velocity of impact, which can be exploited to parameterize sound generation. Consequently, it was imagined that Physics Synth would "surround [the performer] in possibilities", as McCullough (1998) considers a dense medium should.

Moreover, by encapsulating interaction possibilities within the intricate variation of simple forms, it was hoped that the design would afford the "continuity" of a dense medium, where the similarity between adjacent states allows the user to flow between interaction possibilities as if they are "coaxing a material" (Ibid.). In this way, the design sought to respond to Paul's desire for a mode of interaction that affords intricacy and variety, yet in a simple and continuous context. It was expected that performers would be able to draw on their innate knowledge of objects' behaviour in the physical world in order to harness the intricate interaction posed by the Simple Objects. Furthermore, by utilizing a physics simulation, which would produce relatively consistent and predictable behaviour for the performer, it was intended that the interface would allow repeatability of action and, therefore, the potential for mastery, a quality that has been noted as essential for the skill development Paul saw as a critical value of his practice.

While the behaviour of the Simple Objects within the simulation has the potential to be very complex, its form essentially binds the space of different ways each object can be interacted with. This property was crucial in the design for the discovery of interface character. For example, a Simple Object with a defined form will bounce in a particular way when it makes contact with the edges of its parent World. Therefore, each will have its own character in terms of both behaviour and the data it produces to drive sound synthesis.

It was anticipated that the performer would be able to utilize his knowledge of real-world physical objects' behaviour to understand this character intuitively and consequently exploit it during improvisation. Moreover, it was imagined that due to the complexity of interaction afforded by the physics simulation, Physics Synth would provide scope for the discovery of the hidden modes of interaction, which Paul noted as being conducive to experiences of surprise and creativity in his practice. It was expected that the additional complexity resulting from interactions between multiple Simple Objects would further the chance of such hidden playing techniques being discovered.

Additionally, the Simple Objects were designed to provide a sense of a living interface, through the provision of potentially unpredictable variations and permutations of their behaviour in response to the user's commands. Consider a ball that is thrown in the physical world. Where this ball bounces may prove unpredictable, as the thrower might not have the skill or control to make it bounce exactly as required and they may not be able to, or might choose not to, predict the outcome of all subsequent bounces. In this way, the ball and the Simple Objects that replicate its behaviour will subtly resist and respond to the musician's commands in a manner determined by its physical form. Consequently, we envisaged Simple Objects would be experienced as having a "life of their own". However, provision of entirely random responses to interaction, which Paul resisted, was avoided, as Simple Objects' behaviour would always be dictated in a consistent manner by the physics simulation.

6.4.3 Dynamic Objects

Dynamic Objects introduce automated behaviour into Physics Synth. Three types of Dynamic Objects were designed and implemented. Firstly, the Particle Emitter

(Figure 39, left) produces and propels circular particles with a direction and force specified by the performer. The particles produced are in many ways identical to a circular Simple Object. Their size, friction and bounciness can be set using a menu, and touch interaction is afforded using the same joint-based mechanism. Additionally, the performer may control the rate of particle production and a period after which each particle is removed from the simulation. Furthermore, the performer is able to set a pattern of particle production (i.e. whether a particle is produced or not on each of the eight half-beats of a musical bar).

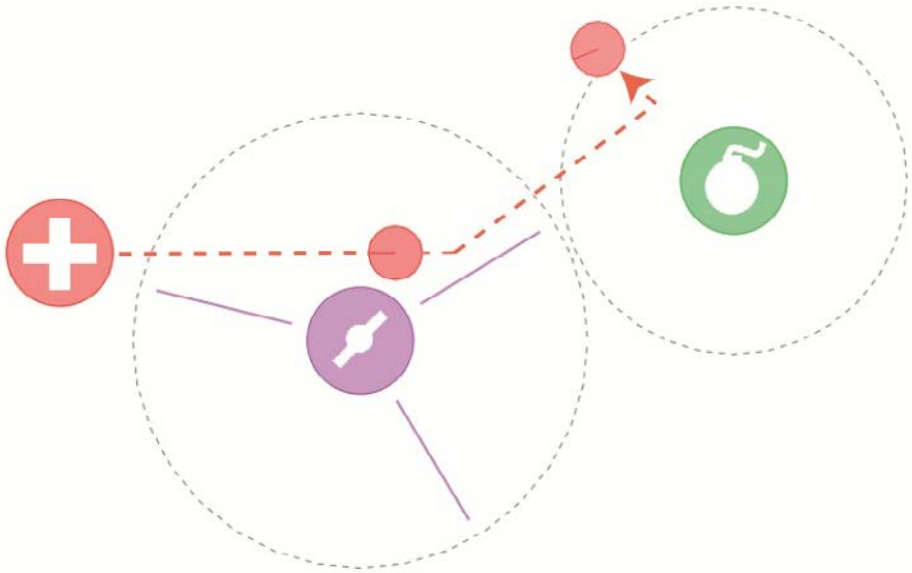

Figure 39: A Particle Emitter (left) produces particles, which interact with a Wheel (centre) and a Bomb (right)

Secondly, the Wheel (Figure 39, centre) has up to eight spokes, which collide with and push objects as they rotate around a central point. The user may set the speed of rotation, size and number of spokes. Finally, the Bomb (Figure 39, right) simulates an explosion by applying an impulse to any Simple Objects or particles within its range, which is shown as a variably sized circular region surrounding its centre. The user is able to set the rate at which explosions take place and their intensity. Furthermore, a pattern of explosions may be set in a similar manner to a pattern of particle emission.

The automated behaviour of Dynamic Objects is synchronized to a global clock signal, which the user is able to specify in BPM. Each Dynamic Object has a parameter that controls the rate at which its behaviour is executed in relation to this global clock signal (e.g. the speed at which a Particle Emitter produces

particles). Furthermore, a synchronize button is provided that brings an object back into line with the global clock if the rate parameter has been set in such a way to cause drift. Each Dynamic Object is represented by a small circular icon, which may be selected using the aforementioned area cursor technique and dragged to any position within a World.

Dynamic Objects were designed to introduce precise repetition into Physics Synth by automating the movement of objects. Consequently, the design responded to Paul's desire to intervene in digital processes, by embodying them in the movement and collisions of objects with which the performer may interact. For example, a Particle Emitter can be configured to propel particles into the boundary of a World, subsequently making a regular drumbeat. The performer can alter the pattern of this drumbeat by holding, flicking, or placing other objects in the path of, the particles that provide its tangible embodiment. It was envisaged that Dynamic Objects would not only make digital repetition tangible in terms of manipulation. Additionally, by externalizing the complex interactions between objects that lead to a pattern of repetition, it was intended that the design would allow the performer to observe and understand ongoing processes, in relation to the sound produced. Consequently, it was believed they might be able to intervene in a more meaningful manner.

The addition of Dynamic Objects into Physics Synth further increases the interaction possibilities afforded to the performer, by introducing the opportunity to develop compound systems of automated object behaviour. Hence, the extent to which the design responded to notions of density and the discovery of character, which were based upon the complexity and intricacy of a few simple objects, is amplified. Furthermore, by taking on automated behaviour, it was envisaged Dynamic Objects would increase the sense of the interface's autonomy and subsequently the sense that it has a "life of its own". In this respect, Dynamic Objects that altered their behaviour (e.g. parameter values) autonomously were considered. However, Paul and I decided against the inclusion of such functionality, as the cause of random variations in object behaviour would not be externalized in the physical properties of objects and, therefore, might not be as easily understood as, say, the repeated propulsion of a Simple Object.

6.4.4 Turning Collisions into Sound

The final constituent of Physics Synth is the mechanism through which the behaviours of the Simple and Dynamic Objects are translated into sound. Physics Synth itself is not responsible for the generation of sound. Instead, OSC messages are transmitted over a local network, which may be consumed by a wide range of software packages for digital music. A collision-based approach is taken whereby control messages are generated when objects within the simulation make contact with each other or the bounds of the World within which they are contained.

Each control message specifies identifiers for the World that the collision occurred in and a sound associated with that object. Sound identifiers are associated with objects in the Physics Synth interface using a scheme whereby the colours of objects relate to a particular sound. To allow the musician to exploit the rich and complex nature of objects' behaviour within Physics Synth, the remainder of each message body is used to communicate the physical properties of the associated collision. These properties include normalised values for the object's position, angular rotation, velocity, angular velocity and inertia, sampled at the time of collision. Furthermore, the magnitude of the impulse vector required to repel the collision is transmitted; this provides the user with a normalised value that corresponds to the force of impact. In the simplest case, a musician might utilize a control message to play a particular note on a synthesizer when, for example, a red object collides, with its attack defined by the force of collision.

Two types of control messages were implemented. Firstly, Raw Messages, which simply transmit values for each of the collision properties. Client software configurations have been developed for both Max/MSP (Cycling 74, 2012) and Ableton Live (Ableton, 2012), which allow performers to easily receive and process these messages. Secondly, Impulse Messages send commands that directly control the parameters of the Ableton Live Impulse sampler (e.g. the time a sample takes to decay). The performer is able to specify mappings between the properties of a collision and particular parameters of the sampler, using a menu within the Physics Synth interface. These mappings are associated with one of the aforementioned coloured sound identifiers.

6.5 Evaluation

The final stage of the process involved close engagement with Paul, and two other musicians, as they incorporated Physics Synth into their musical practices. A daylong workshop was held, during which the musicians were asked to develop a short (10-15 minutes) performance using Physics Synth. These performances were then delivered to a live audience at a public event that same evening. In order to develop their performance, each musician was given a tablet PC with a copy of Physics Synth installed along with the Ableton Live and Max/MSP software required to process the sound events. Additionally, the musicians were offered a Korg nanoKONTROL (Korg, 2012) MIDI controller, in case they required a hardware device to manipulate the sound production software.

The three musicians' uses of Physics Synth were varied in terms of their intent and resulting performance. Paul used Physics Synth to control the Impulse Sampler in Ableton Live. He created four Worlds prior to performance and populated them with multiple Particle Emitter objects, which were configured to create "different pulses". He intended that this configuration would provide a starting point from which he could improvise by altering the parameters of emitters, introducing additional objects and varying the mapping between collision values and the parameters of the Impulse Sampler.

Adam, an improvisational electronic musician, used the position of object collisions to manipulate the frequency of, and filter, four sine waves in Max/MSP. Using a combination of circular Simple Objects, Bombs and Particle Emitters, he hoped to explore the rhythms he could generate out of this "minimal sound palette" and discover if he could "set up kind of processes that will take care of themselves".

The third musician Guy had a background in both electronic and rock bands. Unlike the other musicians, he did not use Physics Synth as the sole instrument of his performance. Instead, he controlled effects on his voice and a bass guitar by processing the control messages produced by Physics Synth in Max/MSP. His performance was an adaptation of one of his band's songs. He hoped that by attempting to perform a pre-set composition, he would explore whether

Physics Synth could be used in his more "conventional" and "tightly structured" (i.e. not entirely improvised) practice.

It was hoped that by evaluating musicians' experiences of using Physics Synth during, and consequently under the pressure of, a live performance, insight would be gained about the relationship between our design and the values of Paul's practice to which it responded. Furthermore, by involving two additional musicians in this process, it was hoped to determine whether the design, which was forged from an exclusively idiographic process, would have worth in a more general context (i.e. beyond Paul's practice).

To elicit the musicians' experiences of developing their performances with Physics Synth, an hour-long semi-structured focus group discussion was held between the end of the workshop and the evening performances. Furthermore, in order to uncover the musicians' experiences of delivering their performances, in the week following, a semi-structured interview (approximately 90 minutes) was carried out individually with each of the musicians. These interviews followed a script that addressed both the experience of performing with Physics Synth and more targeted questions relating to the issues of Paul's practice that underpinned its design.

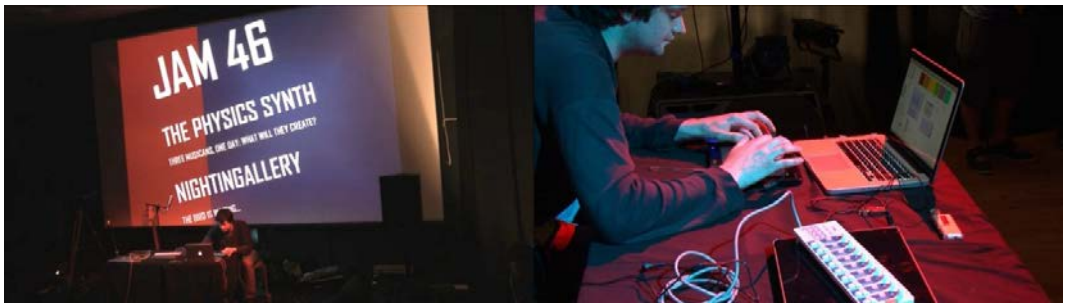

Figure 40: The video prompt showing Adam's performance

As with the evaluation conducted in Chapter 5, post-hoc interviews were chosen, as they were the most practical way to elicit the musicians' experiences of performing, without interfering with the performance itself. Again, a method based upon video reflection (Raingruber, 2003) was utilised to help the subjects recall and reflect upon their experience of using and performing with Physics Synth. Each video prompt was composed of two static videos of the performance, a view from the audience's perspective and one showing the particular musician's interactions (Figure 40).

Transcripts of both the group and individual interviews were analysed using the same IPA technique of the prior study. The most pertinent themes that resulted from this analysis are discussed in the following sections. As experienced electronic musicians, all three participants exhibited a high degree of technical knowledge and understanding in their responses. Consequently, the account that follows not only addresses the experience of performing with Physics Synth, but also in-depth technical consideration of the design's relationship with that experience.

6.5.1 Visual Feedback for Manageable Density

Interaction with Physics Synth was praised for being both "intricate" and "complex". Guy, for example, described how the potential for extensively varied manipulation of sound offered by the interface increased his experience of "expressiveness" during performance. While complex, Physics Synth also seemed to be intuitive and therefore inherently manageable as a tool for use during live performance. Adam attributed the "instantly obvious" nature of interaction with Physics Synth to the visible relationship between the behaviour of physics objects and the triggering of sound. Such comments suggest that the use of a physics engine as the foundation of the design was a successful strategy in affording the dense (intricate, complex and continuous), yet not overwhelming, interaction called for by Paul.

While the musicians were able to create mappings between the basic behaviour of physics objects (i.e. their position and interaction) and parameters of sound generation easily, they exhibited difficulty in exploiting similarly the other more subtle parameters of the events produced by collisions. Consequently, the position of collisions was the primary parameter used to manipulate sound, as the others (e.g. the force of impact) were not made so easily apparent by visual feedback. To rectify this situation Adam suggested adding simple line graphs, showing parameter values, to the interface. By externalizing values, and their interrelations, he believed such an approach would allow them to be more easily understood and therefore incorporated into the manipulation of sound. Guy proposed that physics objects should be supplemented with additional visual feedback, to make collision parameters more salient. For example, to assist in

understanding velocity values he suggested augmenting objects with a "trail if they are moving faster". He believed that design alterations to this effect would unlock an abundance of "really intricate and really nice patterns in the relationship between" parameter values that could be exploited during performance.

6.5.2 Palpable Unpredictability

The idea that the interface might present a somewhat unpredictable response to a musician's commands was fundamental to our efforts to imbue Physics Synth with a sense of agency so it might be experienced as having "a life of its own". The musicians found that the subtle, yet unpredictable, variations in behaviour that physics objects exhibited in response to manipulation, made interaction with Physics Synth more akin to dialogue with another performer than the control of a tool of performance. Guy felt that the experience of interaction was "much closer to working with somebody else […] than that you would expect from an instrument that you are playing". He framed his performance in terms of jamming, a semi-improvised dialogue between musicians, as by responding in slightly unexpected ways to his interaction, Physics Synth presented him with ideas and inspiration: "it always had something interesting to say".

Adam spoke of his previous experiences of tools that provide the musician with a sense of unpredictability. He described how these often forced him into improvising, as they could not be controlled sufficiently. Physics Synth however, was praised for both providing an "unpredictable system" that inspired and guided his performance, while also affording "quite a lot of control when [he] wanted it". Paul also commented positively about the controllability of Physics Synth. He particularly liked how the Particle Emitters would "create a regular beat", but when layered together introduced interference patterns and therefore "dense textures" in sound.

A valuable characteristic of Physics Synth was the fact that while it could be controlled to produce regular and predictable results, these were always one step away from the transition to unpredictability and ambiguity. Paul described how he could use Physics Synth to create regular rhythms, characteristic of digital tools, but also easily delve into a more unpredictable space in order gain ideas and inspiration. Guy described this property in terms of fragility, stating that any

predictable system created was “only one little nudge away” from unexpected behaviour. The consensus amongst the musicians was that this palpable and controllable unpredictability resulted from its source as visible (see previous discussion of visual feedback) and contiguous variations in the behaviour of physics objects, as opposed to, say, the inscrutable product of a random number generator.

These findings suggest a willingness amongst musicians to share agency in their practices, in order to bring about a dialogue with their tools that guides and inspires improvisation. Consequently, traditional notions of musical expression, where the instrument is considered a passive conduit through which the musician (the sole agent) communicates emotion with an audience are questioned (Poepel, 2005). Instead, a dynamic is seen that is akin to Suchman’s (2007) position that agency is not possessed only by the user, but is a phenomenon that results from the dynamic reconfiguration of people and technology during interaction. The configuration of agency in an improvised Physics Synth performance being a product of the subtle balance between unpredictable variation and the experience of legible control afforded by the visual feedback of the physics simulation.

6.5.3 Immediate Interaction with Digital Repetition

Paul applauded Physics Synth for allowing him to “intervene” directly with the process of sound generation, with a particular “immediacy” that he had not encountered with previous tools for digital music. He stated that as a result he gained much more varied and expressive control over sound, which empowered him as a performer to create “really complex, textural rhythms”. Furthermore, he described how the Physics Synth interface “was part of the sound world” and therefore he did not feel a “void” between himself and sound, which he had encountered with other tools. Paul suggested that the relationship he felt with sound when playing Physics Synth was in some respects more intimate than the relationship he experienced with the turntable. Sounds made through gestural interaction with the turntable were said to be “lost forever”. However, in Physics Synth sounds remained as tangible processes that could be controlled as part of a more persistent interaction: “I can set a sound in motion, then I can get a feel for it

and I can try and think of a way to intervene in it or shape it to go somewhere else".

Due to the important role the physicality of the turntable played in Paul's previous practice, there were concerns that a touch screen-based design might not afford the sense of direct intervention he desired. Paul commented that he too shared these concerns in the early stages of the design process, prior to using Physics Synth. To his surprise however, he found that the interface afforded a strong sense of tactile control, which he attributed to the "hands on" interaction he could have with sound due to the mediating physics objects. Adam commented that the interface "[felt] more tangible, more physical" than a previous touch screen performance, which involved "moving a ball around the screen". To him, the crucial difference in tactile sensation was credited to the fact that physical objects' behaviour mimicked that of equivalent objects in the real world.

These accounts illustrate how Physics Synth afforded qualities of tangible interaction with the underlying media of sound production, e.g., the experience of closely coupled and tactile manipulation (Hornecker and Buur, 2006). This, therefore, reinforces the view of Kirk et al. (2009) that the design of TUIs might be in many cases well served by carefully designed non-physical interaction techniques, such as those based upon physics simulation (Agarawala and Balakrishnan, 2006; Wilson, et al., 2008) rather than the provision of physical artefacts.

6.5.4 A Characterful Instrument without Its Own Sound

A principal design goal of Physics Synth was to create an interface with a defined, yet continually discoverable, character. The musicians' comments suggest our design succeeded in fulfilling this objective, as they spoke of uncovering distinct features of interaction with physics objects that had a strong bearing on their use in performance. Adam found that when the position of Simple Objects were manipulated by "playing the centre of gravity", control data could be generated that, while surprising and varied, would eventually settle in a predictable position to produce a desired sound frequency. Paul highlighted how the opportunity to explore and discover the interface meant Physics Synth "had that element of surprise that [he] was looking for" in his practice. Furthermore, there was a

consensus that the characteristics discovered thus far only scratched the surface of the different ways that Physics Synth could be interacted with and its control data interpreted. Subsequently, it is believed that the potential for exploration and discovery of Physics Synth's character would not become easily exhausted over a period of more extended use.

While Physics Synth appeared to have a distinct character in terms of its interaction and behaviour, the musicians voiced concerns that, due to our decision to delegate sound generation to external software tools, it might lack sonic character, i.e., a distinctive sound that would allow it to "be recognized even from a musical recording" (Arfib, Couturier and Loïc, 2005). These fears were allayed in part by Guy's recollection of identifying characteristic traits of physics objects when listening to the others' performances. Furthermore, Adam spoke of how subtle yet unpredictable fluctuations in the behaviour of objects within the physics simulation introduced distinctive "movement and variation in the sound", unlike any he had experienced with other tools, such as those exploiting random number generators. These accounts suggest that despite Physics Synth not making sound itself, distinctive object behaviour may leave recognizable traces of its character in sound.

6.5.5 Skill in Understanding Character

The ability to develop a skilled practice, to potentially "virtuosic" levels, was seen by Paul as a key value of the intricate and nuanced interaction we aimed to design into Physics Synth. However, due to the complexity and unpredictability of interaction with Physics Synth, the musicians questioned its potential for skill development in terms of mastery (i.e. complete and repeatable control). Interestingly, Paul saw this as a positive trait. He stated that if he were to "master a system or an instrument" then the possibility for it to behave unexpectedly would be removed leading to a practice that is more "about composition as opposed to improvisation". When viewed through the lens of agency, this rejection of mastery might be considered also the rejection of configurations of agency that place the musician in complete dictatorial control of their instrument or tools.

The musicians' suggested that an alternative form of skill might be developed with Physics Synth, which would be centred on discovering, and

subsequently learning to exploit, the interface's character. Adam stated that such skill might be found "in learning the sort of data that different things will generate" to become, for example, "a master of understanding the different spin values". Guy on the other hand proposed that the skill might lie in being able to "master the unpredictability" of the system, by learning particular configurations and combinations of objects that bring about interesting patterns of control data.

6.5.6 Making the Interface Visible to the Audience

Prior to the performance, the musicians were presented with the choice to make the user-interface of Physics Synth visible to the audience, by displaying it on a large projection screen behind the stage. All three rejected this option. Adam stated that his intention was for the audience to become "immersed in the sound" of his performance. He was concerned that if the interface was shown, this experience might be lost in exchange for one of "just trying to find out what is going on". Paul shared these concerns, asserting that he did not want to risk distracting from the "listening experience" of his performance.

Informal discussions with the crowd suggested that the musicians' interactions with Physics Synth were not easily understood. Audience members exhibited a sense of intrigue about the musicians' actions, some approaching the stage to enquire about the workings of Physics Synth. When told of this reaction, the musicians appeared concerned and responded by suggesting alternative mechanisms by which Physics Synth could be made more performative. Paul proposed that moving the stage to the centre of the room and thus making it less of a "concert situation" would help reduce the "divide between the performer and the audience". Guy suggested that to prevent such a projection from distracting the audience, rather than simply showing a mirror image of the UI, the interface could be brought more subtly into performances in the form of abstract visual imagery (such as that created by a VJ). These comments suggest that the performers wished their actions to be visible to the audience, but not a central, and consequently distracting, element of performance.

6.6 Reflection on the Design

Paul and I were not the first to utilize a physics simulation in the context of sound synthesis or musical performance. Physics simulations have been employed as a means for the accurate production of sound in contexts including virtual environments (Fontana and Bresin, 2003; Menzies, 2008) and music (Hansen, Marcos and Dimitrov, 2007; Välimäki and Takala, 1996). Furthermore, a range of novel interfaces for musical performance have been developed that, like Physics Synth, exploit the behaviour of simulated physical objects (Dolphin, 2009; Kuhara and Kobayashi, 2011). However, the Physics Synth design represents a novel contribution in terms of the way that the forms of *physics-based* interaction that Paul and I designed respond to particular qualities of his practice, identified in the initial interviews. In this section, Physics Synth and the interaction techniques it comprises are contrasted with previous designs, to highlight the value and innovation of using a physics simulation engine as the basis of an interface for improvisational digital music performance.

The notion of Dense Interaction referred to the complex and intricate interaction that Paul desired with the instruments of his performance. For an instrument to have such density, Paul believed that this complex and intricate interaction should be provided by simple and continuous interactions with a medium, rather than multiple disparate controls. Acoustic instruments have traditionally offered this kind of interaction, as the musician is able to expressively manipulate sound with a high degree of complexity and subtlety, by varying the way they excite a physical material with their hands (e.g. a string, read or the surface of a drum). However, digital tools for musical performance have not customarily offered such Dense Interaction, as the intangible nature of digital audio prevents the musician from having a similarly rich and direct physical relationship with the medium and underlying processes of sound production.

A number of interfaces for digital music performance have been designed that seek to replicate the physical relationship with sound offered by acoustic instruments and, consequently, offer musicians a kind of interaction similar to the Dense Interaction that Paul desired. One approach to facilitating such a direct physical relationship with sound is to map a musician's manipulations of a physical

object or artefact to the parameters of a synthesiser. For instance, the Sonic Banana (Singer, 2003) is a long flexible tube that the musician twists and bends to control sound, while the Squeezables (Weinberg and Gan, 2001) are a set of malleable balls that performers' can squeeze with varying degrees of pressure in order to manipulate a synthesiser. Interfaces have also been developed that sense a musician's bodily gestures and use them to directly manipulate sound (e.g. Dobrian and Bevilacqua, 2003; Comajuncosas, et al., 2011; Donnarumma, 2011; Tanaka, 2000).

By affording a direct relationship between physical gesture and sound, similar to that offered by acoustic instruments, such interfaces have the potential to allow musicians to subtly manipulate sound with the complexity and continuity required of Paul's desired Dense Interaction. Furthermore, if a clearly designed mapping between gesture and sound is utilised, it is likely that the performer will be able to understand the relationship between their actions and the underlying sounds created (Hunt, Wanderley and Paradis, 2003); a quality that Paul saw as essential for the existence of a meaningful improvisational dialogue with an instrument. However, as Paul highlighted during the initial interviews, the provision of a direct relationship between gesture and sound runs the risk of limiting the kind of interactions that the musician can have with digital audio, as there might exist aspects of digital music that may not be meaningfully controllable using gesture, such as precise and infinite repetition of samples.

A number of interfaces have been designed that provide the musician with more abstract forms of physical interaction with sound. For example, The Plank (Verplank, Gurevich and Mathews, 2002) and Scrapple (Levin, 2006) exchange attempts to emulate physical interaction with acoustic instruments for direct physical interaction with underlying representations of digital audio, such as waveforms in cyclic buffers or spectrograms. Additionally, a number of interfaces have been developed that leverage the spatial positioning of tangible objects on the surface of a table (Patten, Recht and Ishii, 2002; Jordà, Geiger, Alonso and Kaltenbrunner, 2007) or pen strokes (Zadel and Scavone, 2006a) to manipulate sound. By allowing musicians to control sound through complex and finite manipulations of physical objects, without attempting to emulate a *realistic* and perceptible relationship between qualities of physical gesture and sound, such

interfaces avoid the limitations of emulating interaction with acoustic instruments identified by Paul. However, by moving away from emulating a familiar and legible relationship between physical gestures and sound, such interfaces might result in interactions that both audiences and performers will find harder to understand.

Physics Synth extends previous work in this area by showing how a physics simulation can be used to create a similarly abstract relationship between physical gestures and sound, which is also easily understandable by the performer due to the intelligible nature of simulated physical objects' behaviour. The Physics Synth design facilitated such interaction through the direct association of a synthesisers parameter values with the intricate, complex and inherently continuous behaviour of objects within a physics simulation. As a result, the musician was offered a rich and expressive space of possible ways of controlling sound during an improvisational performance, while interacting in a simple and continuous manner with a small number of basic objects within the simulation.

The musicians' comments suggested that associating parameter values with visually evident properties of the physics simulation allowed them to gain an understanding of the relationship between the complex and intricate behaviour of simulated physical objects and the sound produced. When designing Physics Synth Paul and I intended that directly associating the physical properties of objects within the physics simulation with parameters of the synthesiser would allow him to understand how his interactions were affecting the complex and intricate patterns of sound created by the interface. Consequently, it was intended that he would be able to enter into a dialogue with the defined and consistent, yet complex and sometimes unpredictable, interaction between objects. Moreover, by leveraging a physics simulation to afford such *understandable* interaction, Paul and I aimed to create an interface with Discoverable Character, which could be explored to provide inspiration for the ongoing development of his practice.

Therefore, it is argued that Physics Synth makes a valuable contribution to the design of future interfaces for digital music performance by demonstrating how the embodiment of the parameters of a synthesiser in the behaviour of objects in a physics simulation can offer musicians interaction with digital audio that is both Dense (i.e. complex, intricate and continuous) but also easily understandable as part of both an immediate dialogue during performance and the exploration of

an instruments qualities over the course of prolonged practice. Some qualities of the interaction between simulated physical objects were not found to be as palpable to the musicians as others. However, the musicians suggested that additional visual feedback, such as the inclusion of particle effects to indicate the force of a collision might circumvent this problem.

The choice to use a physics simulation as the basis of the Physics Synth design was also crucial in our efforts to respond to Paul's desire for Intervention with Digital Processes. Paul was reluctant to use interfaces that replicated the kind of direct gesture to sound relationship found with acoustic instruments, as he felt that the provision of such literal control might not offer a meaningful way to control precise and infinitely repeating processes, which he saw as one of the most interesting aspects of digital music software. The Dynamic Objects were central to our attempts to support Paul in Intervening with Digital Processes in this way. By automating the movement of certain objects, the Dynamic Objects allowed for the creation of patterns of digital audio that the musician could intervene with using interaction mediated by the physics simulation. As a result, Physics Synth was able to exploit the complex and legible interaction with digital audio afforded by the physics simulation, while also allowing for the creation of precise and infinitely repeating patterns of control data that did not need to be sustained by the constant interaction of the performer. In this way, Physics Synth represents a significant innovation over previous work that has explored how a synthesiser can be controlled by simulated physical objects that only move in response to the gestures of the performer (Kuhara and Kobayashi, 2011).

Finally, Paul desired an interface that did not obey his every command, but instead responded to his interactions as if it had a *life of its own*. Paul saw this notion of a living interface as valuable, as he felt that it would lead to instruments that he could enter into a dialogue with during his improvisational performance. Paul advised against using random behaviour as a means to create such a Living Interface. He believed that if an interface behaved randomly, then it would be impossible for a musician to gain an understanding of the effects of their interactions and, therefore, it would be impossible for him to enter into a dialogue with the interface, understand its character and develop skill in its use.

A number of previous designs have explored how simulated animal behaviour can be used as the basis of interfaces for musical performance that exhibit autonomy, while remaining controllable and understandable by the performer. The GIIMP interface (Whalley, 2010) used a musician's interactions with a flocking algorithm, tracked using a touchpad, to control a synthesiser. Similarly, Lush (Choi and Wang, 2010) allowed musicians to create sound from a flocking algorithm by drawing lines that produced sound when crossed by the birds in a flock. In ANTracks 2.0 (Wöldecke, Geiger, Reckter and Schulz, 2010), virtual ants move across the surface of a grid of hexagonal regions, triggering sounds based upon their positions. The performer is able to influence the behaviour of these ants in a number of ways, including the placement of food in particular regions of the surface. Like Physics Synth, these interfaces utilise a visually understandable system as the basis for autonomous behaviour in the interface and, consequently, support the musician in both controlling and understanding its relationship with the creation of sound.

Physics Synth extends this previous work by exploring how the deterministic, yet complex and intricate, behaviour of objects within a physics simulation can be used as an alternative basis for an interface for digital music performance that exhibits autonomous behaviour, while remaining controllable and understandable. The musicians' comments during the study suggest that Physics Synth was successful in achieving this goal. Performing with the interface was described as akin to collaborating with another performer, while interaction with the simulation, and its affect on the sound produced, was described as being both manageable and understandable. Moreover, the musicians' comments highlighted a particular form of skill that might arise when playing *living interfaces* like Physics Synth and, potentially, those based upon the simulation of animal behaviour, where a musician learns to interpret, anticipate and influence the autonomous behaviour of the interface, rather than to simply master its precise control.

6.7 Reflection on the Design Process

The case of Physics Synth further illustrates how focusing on an individual's practice can provide the in-depth insight required for the proposal of an innovative

design in response to the kinds of subtle and complex issues that underpin the experience of live performance. The Physics Synth itself comprises an innovative *physics-based* form of interaction, which was designed to support a number of specific qualities of Paul's desired musician-instrument relationship (e.g. his aspiration for a living interface). Accordingly, it is expected that the design might prove useful to musicians who desire similar interaction during their own performances. Moreover, it is argued that due to their innovative nature, these forms of interaction will contribute to ongoing discourse surrounding the design of innovative interfaces for live digital music performance (e.g. Levin, 2006; Magnusson, 2005; O'Modhrain and Essl, 2004).

The co-design stance taken during the design of Physics Synth explored the consequences of a live performer's more direct participation in idiographic design. Furthermore, the evaluation of Physics Synth with two additional musicians sought to explore whether designs produced using an idiographic approach could be relevant to the practices of a wider group of live electronic music performers. In this section, the Physics Synth design and the approach adopted are further examined with respect to these goals.

6.7.1 The Value of Participation in Idiographic Design

In the previous chapter, by affording close engagement with an individual live performer's practice, the idiographic approach was found to allow me, as a designer, to draw insight and inspiration from a detailed and idiosyncratic understanding of the issues affecting an artist's practice. This in-depth understanding of Paul's practice remained essential to the inspiration and guidance of my input into the *more participatory* idiographic design approach employed in this chapter. However, by increasing Paul's participation in the design process, it was found that this understanding was imbued with a plethora of additional insight, which was grounded in Paul's experience of the relationship between particular qualities of the evolving design and the issues of his practice that it sought to address.

As prototypes of ever-increasing fidelity were developed, Paul was able to experiment with the actual forms of interaction that we were designing. Therefore, the topic of design meetings changed from how particular design ideas *could* or

should respond to the understanding of Paul's practice developed during the interviews, to how particular aspects of the design had actually been experienced in the context of his practice. Consequently, it was found that my understanding of Paul's practice was imbued with insight into the relationship between concrete qualities and forms of interaction and the issues to which the design sought to respond. It is hypothesised that because of such observation and reflection upon Paul's exploration of the design, my understanding of his practice will have been instilled with insight into potentially tacit aspects of his practice, which while inarticulable in the earlier interviews were exhibited in his responses to, and experiences of, particular forms of interaction. Equally, it is expected that Paul's own understanding of his practice and its relationship with design will have been similarly developed throughout the process of designing.

Paul's increased participation in the design process was also found to increase the role that his creative views and ideas were able to play in the proposal of the design. By asking Paul to participate from the earliest stages of the process, he was able to contribute directly to the core ideas underpinning the design of Physics Synth (e.g. the use of a physics simulation as the basis for a synthesiser). This creative input was found to continue throughout the remainder of the design process as iterations were discussed and collaboratively re-designed. Furthermore, it is expected that inviting Paul's participation from the earliest stages of the process will have prevented his creative input from being biased by the existence of an already "well established" design (Hutchinson, et al., 2003), as might have been the case during Andrew's participation in the later iterative stages of the Waves design process (see Section 5.6.4).

The kind of insight that resulted from Paul's increased creative input into the design process was not found to be primarily in the form of static, pre-determined ideas. Rather, the most valuable creative contributions that Paul made to the design process were a product of the combination of his experiences and ideas with my perspective as an interaction designer and HCI researcher. Throughout the design process, I found myself able to draw upon my own knowledge, experiences and competencies to present Paul with ideas about how his practice might be supported and enhanced by novel and innovative technologies and forms of interaction. For instance, in the early stages of the

design process my knowledge of previous research into *physics-based* interaction (e.g. Wilson, et al., 2008) seeded the discussion that led to the choice to use a physics simulation as the basis of the design.

Bødker (2003) framed this kind of contribution by the designer/researcher in participatory design scenarios in terms of helping participants understand and explore alternative ways that design can support and enhance their existing and future practices. By providing Paul with such alternatives, it was found that his creativity was channelled in novel and innovative directions; therefore, inspiring the design to evolve in ways that neither of us could have devised alone.

The idea that the collective knowledge, experiences and perspectives of designers and participants leads to innovative design opportunities has been referred to by Muller and Druin (2012) as a "third space" of design and by Brandt, Binder and Sanders (in press) as "forming a temporary community in which the new can be envisioned". In the cases of both Waves and Physics Synth, it can be seen that such a combination of perspectives led to the development of designs that were both innovative with respect to novel technological possibilities and sensitive to issues of live performance as they inhabited the performer's practice.

In the previous chapter, the innovative nature of the idiographic approach was attributed to the concrete inspiration that resulted from the consideration of an individual live performer's perspective on key issues of live performance. In light of the experience of designing Physics Synth, it is argued that this account of innovation in idiographic design should be subtly reframed to acknowledge the important role that the designer's skills, experiences and perspective play in the exploration and exploitation of insight drawn from the performer's practice.

Moreover, it is argued that, in the case of the *more participatory* flavour of idiographic design adopted in this chapter, the live performer's increased involvement in the design process should also be acknowledged as a valuable mechanism for exploring latent design opportunities that might result from doing design in response to the collective practices of designer and subject (Sanders, 2002). That is to say, initial prototypes of the Physics Synth were found to uncover further design challenges and opportunities, which could then be explored through the further evolution and iteration of the design. For example, my initial suggestion to use a physics simulation as the basis for interaction inspired our co-design of

Physics Synth's Simple Objects. Paul's subsequent experimentation with these objects revealed a desire for more precise and automated behaviour within the simulation, which in turn inspired the design of the Dynamic Objects. In this way, it can be seen that Paul's participation in the design process allowed for not only the initial design space posed by our collective practices to be explored, but also a series of subsequent spaces that arose in response to his experiences with the evolving Physics Synth design.

6.7.2 Generalisability of Idiographic Designs

The evaluation presented in this chapter sought to explore whether the Physics Synth design, which was forged using an idiographic design approach, could prove valuable to a wider group of live electronic music performers. During this evaluation, both of the additional musicians were able to utilise the Physics Synth to create rich and interesting musical performances. They found Physics Synth immediately interesting and compelling, and without encouragement began to explore its relationship with, and possibilities in the context of, their practices. Furthermore, discussion in the group and semi-structured interviews illustrated the relevance of the issues that had inspired Physics Synth, and the appropriateness of its design response, to their practices. For example, Adam spoke of sharing Paul's dislike of randomness in performance but praised the Physics Synth design for tackling this issue in such a way that led to a form of interaction during performance that was both unpredictable, yet inherently controllable. Guy, on the other hand, praised the "intricate" and "complex" interaction, which resulted from the design's response to the notion of Dense Interaction, for instilling his performance with a greater sense of "expressiveness".

While it was found that the musicians in the study were able to leverage Physics Synth to create rich and interesting performances, interestingly, they were seen to utilise the interface in ways that deviated from the intended method of playing that Paul and I had originally developed. Guy, for example, configured Physics Synth as a kind of effects unit for his voice and bass guitar, which he hoped he could "jam" with to get inspiration for the more inspirational aspects of his performance. While this method of playing Physics Synth was markedly different from that which had been intended during the design process, it is clear from Guy's

choice to treat the interface as something to converse with during performance that the design's goal of creating a living interface resonated with his practice.

Furthermore, during part of his performance, Adam chose to control Simple Objects by manipulating a World's centre of gravity. This form of interaction was found to create a sequence of relatively spontaneous control data (for his Max/MSP synthesiser) that would eventually settle in a predictable location. Again, this method of interacting with Physics Synth differs substantially from the direct intervention with simulated physical objects intended by Paul. However, parallels can once more be clearly drawn between Adam's desire to exploit the physics simulation to set a series of events (i.e. movement of a Simple Object) in motion that would generate surprising and varied control data and the design's goals of creating a living interface.

In the previous chapter, it was argued that by addressing an individual's perspective on shared issues of live performance, the idiographic design approach would lead to interfaces that were potentially generalisable to the practices of performers who shared the concerns of the original design subject. The positive reception of the design by Guy and Adam clearly demonstrates that, in the case of Physics Synth at least, an idiographically-designed interactive technology can have value to the practices of live performers other than the original design subject.

While it might be unsurprising that the design was appropriate for Adam, whose practice inhabits a similar genre of experimental improvised performance to that of Paul, it was particularly heartening to see how strongly the design seemed to resonate with the practice of Guy, a musician with a background in more tightly arranged rock music. Consequently, it is argued that the evaluation presented in this chapter reinforces the position that designs forged in response to an individual's practice can be valuable beyond that person's practice.

It is argued that the appropriation of the Physics Synth witnessed during the evaluation further reinforces the argument that an idiographic approach can lead to generalisable designs, when applied in the context of live performance. Throughout this thesis, it has been seen that live performers often view and evaluate interactive technology in a manner akin to a material. That is to say, interfaces are considered in terms of the relationship between their particular characteristics and the expressive goals of a performer's practice (e.g. Section

4.7.2) rather than, say, for the realisation of a particular set of functional requirements. Consequently, it is argued that by supporting the proposal of innovative and distinctive forms of interaction, with respect to issues shared by many performers, the idiographic design approach might lead to a kind of generalisability that is rooted in the creation of designs that have compelling *material* characteristics, which other artists can appropriate to enrich their practices.

6.8 Conclusion

In this chapter, the design and evaluation of Physics Synth, a multi-touch interface for live music performance, was presented. Physics Synth represents a second case study of idiographic design for live performance, which further illustrates the value of focusing interaction design for live performance on an individual and subjective account of one performer's practice. The idiographic approach adopted during the design of Physics Synth was configured to be *more participatory* by inviting the live performer to participate in a design process that responded to his practice, from its earliest stages through to the development and iteration of the final designed artefact.

The design that resulted from this idiographic co-design approach was imbued with a number of innovative forms of interaction, which exploit the capabilities of a physics simulation engine to respond to a number of qualities of the live performer's desired musician-instrument relationship. Consequently, it is expected that the design might be useful to musicians who share Paul's concerns and prove inspiring to interaction designers wishing to provide musicians with similar qualities and dynamics of interaction.

Reflection on the co-design approach adopted, highlighted a number of advantageous consequences of inviting the live performer to participate in the proposal of a response to his practice. Most pertinently, it was found that by increasing the performer's involvement in the design process, a mechanism was created through which the space of design opportunities posed by the collective practices of both designer and artist could be explored in an iterative and dialogical manner, which in turn led to the inspiration of further design possibilities and ideas. Finally, reflection on Physics Synth's evaluation with two

additional musicians (who were not involved in the design process) further reinforced the position that interactive technologies designed in response to an individual's practice might prove relevant to a wider community of live performers.

CHAPTER 7

Conclusions

7.1 Introduction

This concluding chapter revisits the questions posed at the outset of this thesis, to highlight the main contributions that have been made to the topic of interaction design for live performance. Furthermore, a number of recommendations for future research into the topic are given in addition to final concluding remarks, which reflect upon the idiographic approaches that have been developed in response to the challenging activity of designing interactive technology for live performance.

7.2 Contributions

This thesis contributes a range of knowledge, design approaches and designs, which are expected to be valuable to both practitioners and researchers concerned with the design of interactive technology for live performance. In this section, a summary of the main contributions made by the research is given. These contributions are presented in terms of the three principal questions that guided and motivated the research. These questions related to: the understanding of live performance and its relationship with interactive technology, the development of approaches that will assist interaction designers in designing interactive technology for live performance and the design of innovative interactive technologies and interaction techniques for live performance.

7.2.1 Understandings

The first question posed at the outset of this thesis was: “What is the relationship between live performance and the design of interactive technology?” The research

uncovered a range of insight into the relationship between interaction design and live performance, which can be grouped into three key contributions.

7.2.1.1 The Nature of the Issues Faced when Designing for Live Performance

An understanding of the nature of the issues faced by designers addressing live performance was developed. The review of literature in Chapter 2 showed that artists and audiences' experiences of live performances are affected by a plethora of subtle, complex and tacit issues, which are instantiated in potentially divergent ways across different genres and individual performers' practices. This position was reinforced by the findings of the study presented in Chapter 4, which illustrated how a set of complex issues motivated and guided the individual practices of VJs in a number of often divergent ways. The idiographic accounts of live performers' practices presented in Chapters 5 and 6 further exemplified the complexity of the relationship between individuals' practices and the kind of issues identified in the review of literature. Moreover, these studies demonstrated the valuable design insight that can be gained by designing in response to individuals' perspectives on issues affecting live performance, rather than a general picture of those issues.

It is argued that this understanding of the nature of the issues faced when designing for live performance will inform interaction designers and researchers by convincing them to look beyond theoretical conceptualisations of the live experience (e.g. Auslander, 2008) as a starting point for design and, instead, draw insight from idiosyncratic and subjective accounts of the practices of individual live performers. Furthermore, the understanding developed also motivates the use of design strategies that support close and dialogical engagement with the kinds of intricate issues that underpin the lived and felt experiences of live performers and their audiences.

7.2.1.2 An Empirical Account of the Practices of a Group of VJs

The second contribution to the understanding of the relationship between interaction design and live performance made by this thesis is an empirical account of the practices of a group of VJs. This account comprises a set of themes that offer insight into the relationship between VJ practice and the design of

interactive technology. These themes provide insight into how issues identified in the review of literature in Chapter 2 affect the practices of the VJs studied. For instance, the theme Improvisational highlights a perspective on improvisation in VJ practice, whereby participation in the act of improvising is valued not only for the transience and variation it imbues a performance with, but also as a reflexive process that leads to the emergence of ideas that shape a VJ's longitudinal practice.

Additionally, the themes uncover a range of important factors that will affect the design of interfaces for VJs, and potentially other live performers, which relate to concrete qualities of a VJ's interaction with their tools. For instance, the theme Constraining Interaction revealed how the constraints of an interface or technology could play an important role in guiding the creative process of the VJ, both in the moment of performance and during the course of their practice's longitudinal development. When considered as a whole, these themes demonstrated the importance of paying attention to the intricate relationship between live performer and interface when designing technologies for live performance. Moreover, reflection on these themes as a collective led to the identification of McCullough's (1998, p. 194) notion of a Medium as a conceptual framework to assist designers in understanding, and responding to, qualities of the relationship between live performance and interactive technology. This framework was used successfully to guide aspects of the design studies in Chapters 5 and 6.

It is anticipated that the understandings developed from this empirical account of VJ practice will provide insight that will directly inspire and guide designers wishing to create new interfaces for VJs. Furthermore, it is anticipated that the themes developed will provide sensitising concepts (Benford and Giannachi, 2008) that will guide further in-depth empirical studies of VJing from an interaction design perspective, such as those involved in the idiographic design approaches developed in this thesis.

7.2.1.3 Detailed Idiographic Accounts of Two Live Performer's Practices

The idiographic design studies presented in Chapters 5 and 6 involved detailed inquiries into the practices of two individual performers. The accounts that resulted from these studies provide further concrete and detailed perspectives on the issues uncovered in the review of literature presented in Chapter 2 and the

study of VJ practice presented in Chapter 4. For instance, the notion of Salient Interaction uncovered during the study of Andrew's practice highlights the possibility of tailoring the presence of a performer's interactions with an interface in order to evoke a sense of intrigue and enchantment amongst audience members. Furthermore, the study of Paul's practice highlighted how imbuing an interface with a sense of autonomy, or a *life of its own*, might inspire and guide a performer during improvisation. By articulating such idiosyncratic and subjective understandings of individual performers' practices, these studies provide detailed insight into lived and felt experience that might inspire and guide designs in ways that general and abstract theories cannot. Consequently, it is argued that these studies present a range of valuable design insight, which will be either directly applicable or inspiring to those designing interactive technologies for VJing, electronic music performance and other related domains of technology-mediated performance.

Additionally, it is argued that the findings of the idiographic studies presented in this thesis might be combined together, with further idiographic studies of live performers' practices, to contribute to the general understanding of the issues that they provide individual perspectives on. That is to say, the detailed accounts of issues as lived and felt in live performers' practices will provide new ideas and design opportunities, which will contribute to the ongoing academic discourse around the experience of, and design for, live performance. The development of such general understandings might be based upon the practice of *moderate generalisation* where "aspects of [a situation] can be seen to be instances of a broader recognisable set of features" and, therefore, an in-depth idiographic account of a particular situation can support researchers in better interpreting and understanding other situations (Williams, 2009).

7.2.2 Approaches

The second research question addressed in this thesis was: "What approaches should interaction designers follow when designing interactive technology for live performance?" A number of approaches to designing for live performance were developed and applied during the course of the practice-led research conducted. Three important contributions are made with respect to this research question.

7.2.2.1 Understanding Live Performers' Practices using Documentary Film

An approach was developed that employed a series of activities, based upon a documentary film, to enable interaction designers to uncover insight into the lived and felt experiences of live performers, during the early stages of a human-centred design process. It was intended that this approach would support an externally positioned (i.e. not autobiographical) human-centred designer in engaging with and understanding another's live performance practices; a key challenge facing those doing interaction design for live performance identified in Chapter 4.

The approach leveraged documentary film (both the filmmaking process and the resulting film) to inspire performers to reflect upon the subtle, complex and potentially tacit issues that shape their practices and experiences. This approach built upon previous use of documentary film in HCI (e.g. Brun-Cottan and Wall, 1995; Buur, Binder and Brandt, 2000) in a number of ways. Most prominently, the Creative Response stage of the approach extended previous work by showing how engaging the participants in the creative process of editing a film could inspire detailed and methodical reflection about their practices, which would not have resulted from viewing and discussing a film created by another person.

The close and dialogical relationship established with the performers during the application of this approach was found to allow the designer and filmmaker to develop personal and empathic understandings of potentially tacit qualities of the live performers' practices. The documentary film was shown to play an essential role in facilitating such rich dialogue, by both communicating and stimulating reflective discussion in response to initial interpretations of the performers' practices and by allowing such conversations to be augmented with illustrations of how potentially tacit concepts were embodied in the practices discussed.

7.2.2.2 Idiographic Design for Live Performance

In Chapter 5, an idiographic approach was developed to support interaction designers in the challenging creative process of *designing* concrete interactive technologies in response to issues of live performance. This approach focussed design on just one performer's practice, with the intent of allowing the designer to draw concrete design insight and inspiration from an individual's tangible

perspective on key issues of live performance, rather than a general picture of those issues.

Reflection on the application of this approach demonstrated how adopting an idiographic stance to design could support the proposal of innovative technologies that are appropriate and enriching to individual live performers' practices. Designing for an individual's practice was shown to transform the complex and challenging activity of designing in response to key issues of live performance into a more tractable task, while still allowing issues to be considered as lived and felt rather than through abstraction and codification. These findings tally with the discussion of autobiographical design presented in Chapter 4, which argued that designing for one's self can support the designer in responding to complex aspects of experience, while avoiding the abstraction of the design space that might result in the idiosyncratic essence of experience being lost (Boehner, Sengers and Warner, 2008; Sengers, 2006). The study of idiographic design presented in Chapter 5 extends this discourse by showing that an idiographic approach can allow a designer to gain a similarly concrete and unreduced understanding of experience, while designing for another person's practice. Consequently, it is argued that idiographic approaches have the potential to form the basis of design for live performance that is grounded on in-depth, detailed and particular insight into an artist's practice, but that also draws upon the skills, knowledge and alternative perspective of an externally positioned designer, a valuable quality of the human-centred design strategy identified in Chapter 4.

Another particularly valuable feature of the idiographic approach observed during the study was the extended and in-depth dialogue with the performer that arose throughout the interviews and later stages of the design process. The dialogue between designer and performer afforded by the approach was found to support the development of in-depth and holistic understandings of the performer's practice. This proved to be invaluable to the designer when picturing how particular design decisions would fit with the performer's creative aspirations and experience. These findings reinforce previous work that has found the empathic dialogue afforded between designers and subjects to be a key quality of idiographic design (Lindsay, et al., 2012; Wright, Wallace and McCarthy, 2008). Furthermore, it was found that the close relationship between designer and

performer allowed both parties to interrogate and develop their understandings of the experiences and creative views at hand, rather than treating the other's initial interpretation of such issues as a sole, static source of design insight. Consequently, it is argued that the case of Waves extends previous discussion of idiographic design by highlighting it as a particularly valuable approach for designers working with live performers and other creative users, as its findings suggest that the approach can support a designer in unlocking insight into the creative ideas and aspirations that emerge when an artist considers how the qualities of an evolving design or technology could shape the development of their practice.

7.2.2.3 Participatory Idiographic Design for Live Performance

In Chapter 6, a *more participatory* version of the idiographic design approach was developed. A co-design stance was adopted, whereby a performer was invited to participate in all stages of the creative and dialogical process of designing an interface in response to his practice. It was intended that by inviting a performer to participate in an idiographic design process from its earliest stages, the kind of valuable design insight that resulted from the performer's participation in the later iterative stages of the Waves design process would be leveraged throughout the entire design process.

Reflection on the application of this approach demonstrated a number of advantageous consequences of increasing the live performer's participation in idiographic design. It was shown that the process of inviting the performer to participate throughout the entire approach allowed the design to be steered by a rich dialogue between the designer and performer about how the design could and should respond to his practice. Unlike the interview-led discussions of the previous approach, such conversations were imbued with additional insight drawn from the performer's reflective participation in the creative activity of designing and his experiences of interacting with a series of evolving prototypical designs. Furthermore, this dialogical co-design approach was found to allow the performer and me to explore the combined space of design opportunities posed by the knowledge, experience and skills of our collective practices and the presence of the evolving design. Consequently, it was found that the process of designing revealed new design ideas and opportunities, which resulted from the combination of the

evolving design and the performer's creative aspirations and ideas, that would have not come about as part of a static response to the state of his practice at the start of the design process.

While participatory design and co-design are of course established methods in HCI, it is argued that the case of Physics Synth makes a valuable contribution to the discourse around interaction design methods for live performance, by illustrating their appropriateness for designers wishing to develop interfaces for the domain. It is argued that the value of using participatory and co-design methods when designing for live performance lies in their potential to uncover latent design spaces and opportunities (Sanders, 2002) that result from the combination of the designer's knowledge and ideas, the performer's creative aspirations and an evolving prototypical design, at various stages of development.

7.2.3 Designs

The third research question addressed in this thesis was: "How can novel interactive technology be applied appropriately in the design of innovative interaction techniques and interfaces that respond to the practices of live performers?" Two designs were developed as part of a practice-led response to this question. These designs, Waves and Physics Synth, each comprise a number of innovative interaction techniques, which were developed in response to the needs and creative aspirations of individual live performers. It is argued that the research contributions made by these designs can be grouped as follows.

7.2.3.1 Concrete Designs

Both the Waves and Physics Synth designs have been shown to respond to key issues of live performance, in ways that are appropriate and enriching to the practices of the performers for whom they were designed. It is argued that these designs will contribute to the field of interaction design for live performance as designed artefacts that can be immediately used by live performers who share similar aspirations and concerns to Andrew and Paul. For example, it is envisaged that musicians who are looking to explore interfaces that present a sense of having a *life of their own* during an improvisational dialogue might choose to use the Physics Synth as an instrument in their performance. In order to enable

performers to use the designs in this way, the source code for both Waves and Physics Synth has been released under a GNU General Public License (links to Git source code repositories are included in the appendices).

Due to the idiographic nature of the design processes that led to Physics Synth and Waves, it might be argued that their designs will not necessarily be of value to the practices of a wider group of live performers. Further studies will of course be needed to ascertain whether the designs will prove to be of general value. However, the evaluation of Physics Synth with two additional musicians who were not involved in the design process showed promising signs that designs forged using such an idiographic approach might prove to be applicable and enriching to the practices of a wider group of live performers.

7.2.3.2 Interaction Techniques

The designs comprise a number of interaction techniques that respond to the particular issues and challenges faced by the live performers they were designed for. It is envisaged that these interaction techniques will either be directly applicable by, or will prove inspiring and informative to, designers addressing similar issues. For instance, the spline-based interface of the Waves design was shown to offer interaction that is both salient to audience members and provides expressive and powerful control over generative visuals during a live VJ performance. It is anticipated that designers wishing to create future VJ systems might draw upon this interaction technique in order to imbue their designs with similar qualities of salience and live expressiveness. Additionally, the physics-based interaction developed as part of the Physics Synth design demonstrated how a physics engine could be used to externalise repeating patterns of control data for a synthesiser, in a way that a musician could meaningfully understand and interact with. Designers of future interactive technology for digital music performance might draw inspiration from this aspect of the Physics Synth design and, as a result, choose to draw upon physics-based interaction when seeking to develop interfaces that facilitate intimate interaction with the underlying processes of sound production in digital music performance.

7.2.3.3 Perspectives on Design

In addition to being directly applicable or inspiring to interaction designers, it is argued that when combined with the rationales presented in this thesis, the Waves and Physics Synth designs present concrete views about how design could and should respond to particular key issues of live performance. In this way, the designs might form the starting point of, or be combined with, related designs to produce Annotated Portfolios (Bowers, 2012) that map out the design spaces surrounding the issues that they address. For instance, the notions of Salient Interaction and Coalescing Interface and Performance exhibited by the Waves design might be combined with alternative designs that explore how the interactions of a performer could be made more visible to an audience (e.g. Lew, 2004; Taylor, et al., 2009; SmithsonMartin Inc., 2012) to produce an informative and inspiring portfolio of possibilities that a designer could draw upon when deciding how to create an interface that configures a performer's presence in a particular way.

7.3 Future Work

Three principle avenues for the continuation of the research presented in this thesis are recommended, which include further exploration of the potential generalisability of idiographic designs, shifting the focus of design to the audience's experience of technology-mediated performance and the application of the design approaches developed in other areas of interaction design.

7.3.1 Broader Evaluation of the Idiographic Designs

In the previous chapter, Physics Synth was evaluated with two musicians who were not involved in its design process. It was found that these artists were able to use the design to create compelling performances. Furthermore, when interviewed, these performers' comments suggested that the design resonated with many of the issues that they faced in their practices. Therefore, it was suggested that while bespoke to the practice of just one performer, designs resulting from an idiographic approach could be appropriate and enriching to other artists. However, it is expected that interaction designers looking to utilise idiographic design might seek further reassurance about the general value of

designs that result from the approach before adopting the strategy as part of their practices. Consequently, it is argued that further studies should be conducted that explore, with larger groups of performers, the potential generalisability of designs resulting from an idiographic approach.

The release of both Waves and Physics Synth as publically available pieces of software might provide a basis for such studies. It is expected that the prospect of documenting, understanding and iterating designs in response to the dispersed and varied user group that might arise when using a public software release as the basis for an evaluation will pose a range of interesting methodological challenges, which may lead to the further development of the approaches presented in this thesis. For instance, it is anticipated that conducting in-depth and idiographic research into the experiences of people who are not geographically co-located with the researcher will prove to be particularly challenging.

7.3.2 Looking to the Audience

The research presented in this thesis has primarily focused on the engagement with live performers' lived experiences and creative views during the design of interactive technologies for staged performance. Consequently, the idiographic consideration of audience members' perspectives on live performance was not explored as a possible source of insight for the design of interactive technology. Broadening the focus of the research to engage more directly with the audience might yield a range of valuable insights into the changing experiences and practices, which are arising amongst the spectators of increasingly technology-mediated forms of live performance. Furthermore, applying the idiographic research method developed with individual audience members might provide a valuable basis for the design of performances where audience members are asked to take a more active or participatory role in the experience, such as the Mixed Reality performances described by Benford and Giannachi (2011).

For instance, a possible research project might investigate how audience members' use of social media while watching live events (both *live* and broadcast) affects the sense of community felt between both co-located and distant spectators. Alternatively, audience members' use of smartphones and compact digital cameras to produce and share recordings of live performances might be explored, with the

intention of designing technologies that leverage these emergent practices as the basis of new revenue streams for performers (e.g. by exploiting the potential collectability of such bootlegs). As the practices and experiences of audience members are expected to be similarly complex and multifaceted to those of performers, it is expected that the idiographic approaches developed throughout this thesis will provide a valuable methodological starting point for such further research.

7.3.3 Wider Application of the Design Approaches

The design approaches presented in this thesis sought to support the designer in engaging with the kinds of subtle, complex and, potentially, tacit issues that underpin the experience of live performance. It is anticipated that these approaches might be useful for those conducting human-centred design in response to people and practices that share similar qualities and challenges with live performance. However, it is argued that further research will be required to ascertain whether they will be similarly effective in other situations and how they might be tailored to meet the needs of particular groups of people. In the following sections, a number of opportunities for the application of the design approaches developed beyond the domain of live performance are identified.

The approach developed in Chapter 4 utilised the viewing, discussion and creative editing of a documentary film to inspire VJs to reflect upon, and hence articulate, tacit aspects of their experiences and knowledge of VJing. It is anticipated that this documentary-centred approach might prove to be an equally valuable means to support designers in understanding other practices where people's knowledge and experience might be to some degree tacit. For instance, the approach might be applied to support designers in understanding the tacit knowledge-in-action that Schön (1991) has described as underpinning professional practices such as engineering, architecture, management, psychotherapy, and town planning. Alternatively, aspects of the approach might be utilised to inspire reflection and surface tacit knowledge in contexts other than the design process, such as education. For instance, getting students to reflect upon and understand the relationship between their actual experiences of designing and the theories and concepts that they are taught in lectures is a widely acknowledged

challenge faced by design educators (Nelson and Stolterman, 2003). The Creative Response activity, or the more abstract notion of using the creative editing of a film to inspire reflection on tacit knowledge, might be used as the basis of activities or interfaces that support students in reflecting on and understanding the connections between the practical and theoretical aspects of designing.

The idiographic design methods developed in Chapters 5 and 6 were found to have a number of advantageous qualities, in the context of designing for live performance. The first of these qualities was the close and empathic relationship between designer and subject, which resulted from the dialogical nature of the approach. By allowing the designer to engage closely with an individual's practice, the approach was found to lead to the development of in-depth, personal and, potentially, tacit understandings of the performer's practice that could be used as insight to inspire and guide an appropriate design response. The turn to experience in HCI (Wright and McCarthy, 2010, pp. 1-8) has seen people's lived and felt experiences established as a central concern for interaction designers and researchers alike. Where once interaction design focused on usability and efficiency in the workplace, designers and researchers now grapple with notions such as playfulness (Gaver, 2009) and embodiment (Schiphorst, 2009) in complex situations such as newly formed intimate relationships (Thieme, et al., 2010) and the lives of homeless people (Le Dantec and Edwards, 2008). Wright and McCarthy (2008) have argued that empathising with users is an essential requirement of design processes that seek to understand and respond to lived and felt experience. Therefore, due to the close and dialogical relationship afforded between designer and subject, it is hypothesised that idiographic approaches might offer a particularly valuable way to assist designers in gaining the empathic understanding of people's experiences required when designing for such complex situations and contexts.

A second key quality of the idiographic approach was the particularity and specificity of design insight that resulted from the exclusive consideration of an individual's practice. Such individual perspectives were found to be invaluable when proposing a design response to the complex, subtle and multifaceted issues faced when designing for live performance. Focusing on one performer's detailed personal experiences of such issues demarcated a concrete space for the designer

to work in; consequently, replacing the challenge of engaging many potentially contrasting views and experiences in design with the more tractable task of proposing a bespoke design in response to an individual's perspective. It is argued that this characteristic of the approach may make it particularly useful in situations where a designer is faced with multiple, potentially conflicting, requirements and viewpoints. As a result, designers employing the idiographic approaches might be equipped with a tool that allows them to engage with complex and multifaceted design spaces, while avoiding the reductionist treatment of people's experiences that might be required if the designer is to consider a multitude of perspectives in design (Sengers, 2006; Boehner, Sengers and Warner, 2008).

Throughout this thesis, it has been shown that interactive technology plays a very particular role in live performers' practices. Technology was commonly treated as a material – with qualities that inspire, constraints that guide and characteristics that can be discovered – rather than as a tool that facilitated the achievement of a goal alone. This particular role of technology in live performance might explain the appropriateness of idiographic methods for the domain. In Chapters 5 and 6, it was found that idiographic design led to interfaces that represented concrete responses to individuals' perspectives on issues shared by a larger group of people. These concrete responses might be considered to have their own *material properties* that will prove to be interesting and inspiring to performers who share in the abstract issues that they were designed in response to. Therefore, while an idiographic design response to one performer's individual perspective on a set of issues might differ from those that would have been created in response to other performers' perspectives, it might still have qualities that will allow it to be explored and used as the basis for an inspiring and enriching creative practice.

In this way, idiographic design stands out as being a particularly relevant approach for designing interfaces that will be used as the tools and materials of creative and artistic practices. For instance, the approach might be applied in the creation of interfaces for non-performing artists, such as digital video artists, who might seek inspiration from the particular qualities, constraints and characteristics of an interface that has been carefully designed in response to another artist's

practice. However, the approach might prove to be inappropriate for non-creative settings, where the goal of design is to create interfaces that fulfil the specific functional requirements of a wide body of users. Therefore, it is argued that caution should be applied when seeking to use idiographic design to address multifaceted issues and people's contrasting views in design in contexts other than live performance, as many of the valuable traits of the design approach might be bound to the creative context explored in this thesis.

7.4 Concluding Remarks

The research presented in this thesis investigated the design of interactive technology for live performance. A practice-led approach was adopted, which involved my participation in both the exploration of, and design response to, a number of live performers' practices. Live performance was found to be a particularly challenging domain to address in interaction design, due to the subtle, complex and potentially tacit issues and creative aspirations that underpin the lived and felt experiences of individual artists' practices. Three approaches to support the elicitation of design insight into, and proposal of concrete designs in response to, this complex and multifaceted domain were developed and applied to a number of live performers' practices.

In this concluding chapter, it has been argued that the outcomes of this practice-led design research contribute to the understanding and practice of interaction design for live performance in a number of important ways. It is hypothesised that perhaps the most impactful of the contributions made by this research will stem from the idiographic approaches to designing for live performance developed. The application of these approaches illustrated the kinds of in-depth, detailed – and most importantly – reflective and dialogical engagement that can result from close and prolonged interaction with individual, or small numbers of, performers during the design of interactive technologies for live performance. Consequently, it is argued that an idiographic design stance offers a practical way to draw upon a close and dialogical consideration of individual live performers' experiences and creative views as a source of inspiration for designs that are both innovative and sensitive to the detailed and subjective nature of the issues that underpin live performance.

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Appendices

APPENDIX A

Example Interview Schedule

Semi-structured and focus group interviews were held throughout the course of the research presented in this thesis. These interviews were guided by short interview schedules, which each consisted of a list of questions and/or topics that were to be discussed. These schedules were not followed strictly. Rather, I would often improvise questions to explore topics and ideas brought up by the interviewee. This section includes an example of one of these schedules, from the last of the three interviews that were held as part of the Waves design process described in section 5.4.

Possibilities/Potential

One of the issues brought up in the workshop was the value of having a large space of manipulation possibilities/potential to explore in a performance. So for example:

- A large space of control possibilities
- Potential for complex and varied manipulation of content/visuals
- The ability to realise any possible idea in your head
- To add style and variation to the way you complete a task
- Flexibility to react to influences in the environment
- Control which affords exploration of possibilities (experimentation) live

Questions (A)

1. What part does having the potential for great control/manipulation play in your work?
    a. Are any of the above types of possibilities relevant?
    b. Are there any things that are important and have been missed?

c. Does VJ software need to provide you with a big space of control?
d. If it was achievable, what would having unlimited control add to your work?
e. Do you strive for such possibilities in your current work?

A set of Trade-offs was mentioned alongside great possibility for control.

- Control needs to be manageable
- Cannot control more variables than you have fingers
- Control needs to be immediate and predictable
- Technical limitations of complex controllers (e.g. losing cables)

Questions (B)

2. Do you experience such trade-offs with manipulation possibilities in your work?
    a. Which are relevant?
    b. Have any been missed?
    c. Do you think that limiting yourself in one area can free you in another?
    d. Do your current tools tackle this trade-off, if so how?
3. How could technology provide you with a massive space of possibilities for manipulation and control? How would the trade-offs be tackled?
    a. What levels of possible manipulations do the different tools you work with afford?
    b. What kind of problems arises with each?
    c. How do the example technologies relate to possibilities for manipulation and control, do they support, hinder, are irrelevant, and why?
    d. When you see these technologies, do they inspire any ideas or possibilities about how you could have a large space of possibilities?
    e. What would the ultimate technology which provided possibilities for control and manipulation of your performance look like?

Experimentation and Improvisation

Another issue discussed was the importance of being able to experiment and improvise during a performance. Improvisation was seen to contribute the following:

- The ability to generate new ideas in the moment through trying things out
- The ability to react to factors in the environment
- To be creative on-stage during a performance

The following **limited** experimentation/improvisation:

- The control/manipulation of your tools/interface
- Pre-prepared materials
- Visual and their format (e.g. 3D Disco anaglyphs)
- Context (e.g. commercial audiences)

The following **aided** however:

- New technological possibilities
- New possibilities for control and manipulation

Questions

4. What does the ability to experiment and improvise add to your work? What factors affect your ability to do it?
    a. Are any of the above relevant?
    b. Are there any things that are important and have been missed?
    c. Is it important to experiment and improvise in your work?
5. How could technology support experimentation and improvisation?
    a. Do you feel you can experiment live with your current tools?
    b. What kind of limitations do they impose in this context?
    c. What are the good things?
    d. What qualities should a technology that lets you experiment and improvise possess?
    e. How do the example technologies relate to experimentation and improvisation a performance, do they support, hinder, are irrelevant, and why?

f. When you see these technologies, do they inspire any ideas or possibilities about how you could experiment and improvise more in your work?
g. What would the ultimate technology that let you experiment and improvise within your performance be like, or what qualities would it have?

Limitations

The VJs all appeared to be working against many limitations in their work. These included:

- Hardware
- Software
- Visual format
- Compatibility
- Money
- Size
- Time (to explore ideas)

One of the most interesting things that came up was that limitations were often seen as beneficial and shaped the work of the VJs. For example:

- New directions inspired as limitations removed
- A tight space of possibilities allowing for manageable control possibilities
- The white cube in Elliot's work allows him for massive control possibilities as they are of a small space
- Limitations give you something to work against and can be inspiring
- Stringed instruments give unlimited possibilities, but over a tiny part of the musical spectrum

Questions

6. Do you face many limitations in your work? How do they affect what you do?
    a. Are any of the above relevant?
    b. Have any been missed?
    c. How have they shaped what you do today?

7. What do you think of the idea that limitations can be beneficial for a VJs work?
    a. Do limitations have a positive influence on your work?
    b. If so, how?
    c. Could you give an example of when a limitation has inspired you?
8. How could technology exploit limitation to enhance a VJs performance?
    a. Do any technologies impose limitations upon you in a beneficial way?
    b. What kind of limitations?
    c. What about the technologies you currently use?
    d. Do any of the example technologies impose limitations?

APPENDIX B

Example Interview Transcript

Audio recordings of the semi-structured interviews and focus groups conducted were transcribed prior to analysis. During the initial study of VJ practice described in Chapter 4, I conducted this transcription myself. However, during the idiographic design studies (Chapters 4 and 5) a transcription service was used. This section includes an example transcript, again from the last of the three interviews that were held as part of the Waves design process described in section 5.4.

Q: So the first thing is the idea of having kind of a large base of possibilities. So just a massive sea of things to explore, rather than being kind of limited in what you're doing. So things like, I don't know, like a guitar, so you have a big space of ways you can interact with the string.

Or just like your – or just a VJing software that gives you loads of different ways to interact with something. Or the ability to just take what's in your head and make it real in kind of a dream world, that kind of thing. Or again something like you can, because you've got so many possible ways to do something, you can add style to the way you do it rather than just doing it. I just wondered, I guess do you kind of see this thing I'm kind of getting at here?

A: Yeah it's something you see constantly in software especially sort of visual software. The main ones are very simple to get going with but they've got quite a strict architecture interface; this is how you do it, this is the process you do it. Which is fantastic for many gigs where you just – or many things that you want to do, or you just want to turn up, plug in, bang, gone. But when you're doing more project or specific installation/performance type stuff then having real flexibility becomes a real requirement. So that the more node based or coding, processing, whatever, it is becoming stronger for that kind of thing because you can do a lot with it. So what is interesting is having a framework, having a really flexible base level system which is how it's done.

But then you can drop interfaces or methodology on top of that, or plug it into it. There's a programme called VJO, visual jockey, which is kind of like that. And quite a few people have

taken that as a core engine and built their own sort of – their own basic interface on it. So you've got that, it's quite nice because you've the flexibility of, you know, it'll do exactly what you want. But then loading up a specific, I was going to say skin, but it's not, it's a lot more than skin. It's got the functionality everything built into it. And I think that will be very important for this sort of project. You know to be honest I envisage a range of different interfaces according to the thing you're doing with it. You know to bespokely create your interface according to, you know, are you just going to VJ?

And you just want it to look fancy and sort of that kind of thing. You want a very different interface compared to if you're doing a full audio-visual performance from it. So flexibility and possibly potential et cetera, I think will be really important.

Q: So interesting, VJ, V Jockey kind of an underlying thing? Like is it…?

A: Well Visual Jockey is a programme in itself. It's kind of stopped development now. It's been around for years, but it's sort of nodal based, but not, yeah kind of like that.

Q: More like max?

A: It's kind of like max yeah, you can sort of connect different things up and yeah it's node based. But – so people take that as a rendering engine, as a thing, and then can build, for example the hypnotiser which is a very media server. Well it's not expensive in media server terms but it's still 10 grand for PC software. That just uses Visual Jockey underlying. But they've built their own interface to make it very easy. You know you've got your clip banks, it's a very straightforward interface for playback but it runs on visual jockey. So yeah that's sort of – that's an interesting thing.

Q: That kind of, I guess that leads to – I know I won't move on just yet but it's interesting; it's kind of like the, why do you think people should put another interface on top and then just go straight into Visual Jockey?

A: Mainly because it's quite hard to get into. You know, a lot of software that's sold, you want the – it's easy for the user to get into. It's straightforward. You know modulator it takes you an hour to get your head round it. It's still possibly – you know you keep on developing and stuff. But to actually get it playing and performing and doing stuff with it; half an hour, an hour no problem. And if you turn up at a gig, load clips in; bang gone, you're away, you're performing it – it's really straightforward. Very powerful stuff, it's really straightforward. Whereas something like Visual Jockey, or even to a certain extent VDMX, you need to really – you need to spend quite a lot of time building the interface or building what you want it to do.

It can do pretty much anything you want to a certain level, but then you need to build that in using menus and using max type interface which takes a while. And it's – for some people get – a lot of people get frustrated by that and it's like, "Oh no I just want to play clips and just want to be able to do it." So you know people will take what is a powerful underlying thing and then

build something that's quite simple to use on top of it, just using that functionality. That ties you into whatever functionality they see fit. I mean that's a problem with a lot of VJ software is it's built by VJs. And it's built by VJs who have a certain goal or certain style that they want to achieve. And so they build the software that they want to use, which in many instances mean that what other people want to use is a different thing.

So there's frustrations et cetera in that. But yeah, you know that balance of flexibility and ease of getting going kind of seems to be the main, yeah the main sort of argument in that.

Q: It's interesting, it's like I guess you do want all the possibilities in the world, but you don't – you don't want them all at once. You don't want them – you want to pick and choose them.

A: Well you know, it's almost like, yeah, I mean if you wanted all the possibilities in the world you'd start with a blank C++ interface and just code it completely. But a lot of people haven't got those skills and a lot of people don't want to spend time doing that. They just want to get on playing back. So it's almost like yeah there's grades of flexibility and creating what you want. I am fearing much more now down the – spending a lot of time developing exactly what I want it to do. But even that is quite hard in terms of my time, you know, sort of to devote the time to do that. But I'm kind of forcing myself because I know the results at the end of it will be much more what I want.

Q: Cool, creativity is coming in, in the build there a lot more.

A: Yeah there's – I'm much more interested in what you can do, you know not necessarily how you're creative by playing clips back. You know what order you play clips back, what effects you drop on a clip. That can be kind of a bit boring to be honest. Especially performing – I'm much preferring what can you generate? What generative visuals can you take from data? What data visualisations can you make from different; you know millions – different inputs? Whatever it is, that really interests me. You know not just the sound reactive visualise or whatever but it's really sort of taking data and producing beautiful real-time visuals, which computers are more than powerful enough to do that now.

Q: Do you think generative I guess because like you say they're creating visuals and generative stuff. Do you think that – just I guess that is the ultimate space possibly? You're not limited by any media format. Well I suppose you are – you're limited by the graphics, but…

A: Yeah you're limited by your machine really. I wouldn't say ultimate, it's a style. You know there's definitely a big, still a huge following in replaying – playing back clips in a certain way or whatever you want to do. You know I'm not dismissing that at all. But I think for me personally what I want to explore with the audio-visual work I want to do in a quite minimal electronic kind of sense. Is that I really want it to be a data sort of having that feel of data and building stuff from single things. You know there's that one thing that we've done which is kind of like – pretty much takes one pixel. The whole show is built on one pixel.

Q: Really?

A: Yeah.

Q: What's that?

A: Magnetic man the dub step stuff.

Q: Oh yeah.

A: It's kind of changed now. When we started, me and Elliot we sort of…

Q: Was it just one colour?

A: It starts off as one pixel in the middle of the screen and then whatever effects – however you affect that pixel like sound reactive elements and stuff, building up to lines and grows and repeats and stretches and warps and folds in on itself. But it starts from one – like the only media is one, is a pixel. It's not – there's not like bags of media playing back which is really exciting. And it's – sometimes those sorts of performances where you're really restricted – you restrict yourself but what you do, you create amazing stuff. And that's just one example of you know not necessarily – you know it's being sort of flexible and being interesting with code. You know code can be beautiful and being able to play with code and drop bits of code in.

You know sort of, you know might be a processing patch or might, you know you're just building different patches in OF and having an interface where you just drop those different things in which affects or creates stuff in a different way going off mainly through the sound or the OC sort of information coming from the audio.

Or vice versa the visual, you know it might be the sign wave is – you know just a simple audio sign wave with a couple of effects on it is a visual thing that you can visually change. So you can change the shape – like draw, we draw the shape of the wave on the screen is affecting the sound, or stretching it out or pulling it. So you're almost using a visual interface. Not a visual interface but you're using the visual element to control the audio.

Which again for me that's what makes multi touch, especially multi touch where people can see what's happening. That's when it becomes, because you couldn't do that anywhere else. If you know what I mean, it would be hard for a mouse to affect something on screen. But if you can actually physically redraw, re-pull or realign whatever on the screen visually is the audio thing. Then that could be really – I've no idea what that would be yet or how that would work.

Q: I guess it's just, yeah I guess it's more visible isn't it. But it's not just that you can – because you could do all of those things with a mouse. Although could you I guess?

A: Probably, but it would be a ball ache-er, it would be really hard. Because if you've got multi-touch then you really can pull many things at once. You know it's often when you're controlling

audio you need to do several things at once. You're changing a sequence, you're bringing things out, you're bringing things in. Midi controllers are good. You can have…

Q: Yes they are, they're very multi touch aren't they?

A: They are multi touch, you can affect it whatever, but if you can actually go onto a screen in front of you and see the visual thing and pull that out exactly how you want. So you're not detached from what you're affecting through the scale of the midi controller. If you're literally – if it's got the resolution, it's got the accuracy to affect it like that, then it becomes really interesting. What you're doing becomes interesting to the performance as well.

Q: So how do you think interesting? Do you think it's to the audience or…?

A: To the audience and to the performer I think. I think it would be a bit of both. I think it would definitely add interest to the performance.

Q: Cool, so I guess with a mouse you're not physically anchored to any control, like you don't have a physical mapping, so you can do anything. With multi touch you get simultaneous control but you aren't anchored down in it. So you've got more power with it.

A: Yes and it's – yeah you haven't got the scale factor thing element. It's like graphics tablets. I've always had a real problem with graphics tablets because your hand movement doesn't represent the same distance. You know if you're drawing a line from A to B on a piece of paper with a pen, you know exactly what distance, but it's that rescaling of…

Q: Oh these things where you can't – it's not like the screen?

A: Yeah, you're just sort of drawing on it and it's remote, sort of – yeah it's a remote representation of what you've just done on screen. There's that disassociation thing, I guess people get very, very good at it and practice. And I guess that goes down the line of an instrument type of thing.

But I still think having that headset in front, the audience can see you doing things. You know sort of that – excuse me – that gestural, that movement, that tangible thing is happening which is affecting the audio and the visual performance to the audience. They can see it and I think that's a fundamental. Well that's a fundamental reason for wanting to do it.

Q: Cool. There's one. I guess we've rushed on these a little bit. I guess there's a – I think you've covered these kind of things, just kind of these, if you had more possibilities there's things are raised like a lot of people mentioned kind of trade off. So like I guess control needs to be managed but I think you mentioned that.

A: Yeah.

Q: Toby mentioned more – you can't have more variables than you can have fingers possibly, or – and I guess immediate and you need to be predictable. I guess are any of these kind of…?

A: Yeah it needs to be reliable, you know sort of predictable and reliable sort of, and exact. No they're all totally fine, I think that's where it becomes – the flexibility becomes important. You know sometimes you know software can be just overwhelming with the choices you've got to do things. It becomes too much like you don't get anywhere because you've got too much choice.

So it's having something that you can quite simply create the interface, create the control method. Yeah, you can't control more variables but you have more variables on screen than you have fingers that you're not trying to control all at once, but yeah that's obviously a very good point. And also the fact of controlling things with five fingers is quite a…

Q: Cognitively demanding, isn't it?

A: Yeah it's a real...

Q: It's a hard thing to do isn't it?

A: Yeah I mean if you play piano, you've learnt how to do that but there'll be a lot of… but then that's not necessarily a bad thing. You know it's not necessarily a mass-market type of thing wanting to create an interesting instrument that might take quite a lot of time to… Well I think that's quite important it's something that can be expandable as a skill of performing with it become better.

You know if you can start you know sort of being able to really have the cognitive control of all your fingers and sort of multi touch then more things can be added to it. At the start you're sort of using two fingers; your two index fingers or thumb and index finger to do it, and then you start bringing more in as it becomes expanded.

Q: Do you think that would be something? I guess – do you think that would be something interesting, something that was – I guess something where people looked at what you're doing with the multi touch screen and saw that, like had that kind of, "How's he doing that?" Not just, "How's he doing that visually?" "How's he doing that kind of physically?" Or acknowledge kind of a skill.

A: Possibly, yeah definitely if it's – if it's relevant I think there's a sort of danger of going a bit too far. You know sort of trying to make it look more – yeah I mean some people I think would take it to like a – a bit fake if you know what I mean. So going beyond – beyond just doing what you're doing to create. You know sort of becoming more elaborate with movements and things like that. I'm not – I'm not interested in that but some people might be. That might be a really good thing for people but…

Q: I guess electric guitars and stuff, they never meant to be – they weren't designed to be difficult they were designed to let you do a task. What do you think it's about? It would be about an interface that would let you develop something that was quite skilful.

A: Yeah I guess it's always; it's not making it difficult for the sake of making it difficult. It's making it so that you've got the control. You've got – yeah it's hard, without you know sort of knowing – having an exact end goal for what it is. You know it's still – I'm still in the very much not quite sure what it is yet. It needs a lot of time spent. There's a thing about making it complicated and just complicated enough to achieve the things that you want it to achieve is always… You know having the flexibility to add elements that make it a bit more complicated but it's – there's a real sort of payback for that complexity coming in. I think, is that a good way of explaining it? (Laughs)

Q: Well do you think making it a little bit more complex, than like giving you a bit more complexity therefore maybe possibilities. I don't know if that's true, is there a relationship between complexity and…?

A: There definitely can be. This is, you know this is where it's – excuse me again – the real design of what it is you want to achieve. But again I do feel that it will be a multi interface, you know a multi choice interface type of scenario. Or a modular kind of interface that you can add more on, you know. In some ways, I can see it being quite a lots on screen type of thing that you can drop clips or you know move things around. But also would love to see if there's a way of having a very, very simple non-data, non-button, non-sort of slider type interface which is a visual control. You know maybe it's just – again I'm going back to wave forms because I'm visualising and verbalising it.

But it's just a waveform which is going across the screen and your movements are affecting that wave form. Which is, you know, then your sort of duplicated offset built up of different effects, delays can be dragged onto it – dragged onto this wave – you know sort of wave form. So you're physically building up the actual sounds and it becomes something completely different. It's not an interface for a programme; it's just a shape that is malleable on screen which then creates a sound. If you kind of understand that.

I've no idea how it would work yet. You know that's what I've got to start spending time doing as well, is working out, well could you do this? What would happen? What would happen if you just had waves that were represented in a visual form?

You know so I'd love a beautifully simple interface which you know was – you know it was an aesthetically beautiful thing as well that you just performed with. I don't know, you know you see things like Joe upstairs when he does his – he's got a light which is just a ball. A light ball with a light sensor above it and he makes all the sound; he makes sound with it by how much light is let out the ball.

Q: With a light?

A: Yeah just like a bulb in a ball like that. It's almost like a – whatever you call it, a fortune teller type of thing. So when you let light out the sound changes, you know you can see a tangible

thing. I kind of like that; I like that sort of simplicity thing, so yeah. But at the same time I would definitely not want it to just be that. I think there's a case of that being, you almost like zoom into an instrument.

So if say you had a sequence kind of programme running, that you can zoom into something which then you can really sort of play with, and stuff happening in the background. You can zoom out, bring a different one into focus, zoom out. Yeah possibly – I don't know how complicated that could get but it can be really interesting in a performance sense.

Q: I don't know, but we'll see. The next one, I guess this is the main one. The next one there may become overlaps with the liveness one. But just a little bit of talk about kind of experimentation and improv. Just I guess what – so generally what do you think, just the ability to experiment live and improvise live adds as opposed to…?

A: Yeah definitely can because that is in essence what live is to the – you know especially a solo performer. Being able to adjust what you're doing on the fly and improvise is kind of what makes it live. Well one of the reasons to live, so yeah I think that is important. It's not necessarily everything I'd do is improvised but having – yeah being able to experiment. And it kind of does; experiment and improvisation always does depend quite a lot on previous skill sets. Or you know say you're a jazz musician saxophonist; you've got to have pretty damn good skills at playing the saxophone if you want to improvise live on stage. And be able to, you know, sort of compass the full range of your skills.

And I think that's something else that it can be quite easy, improvisation can become a mess if the skills – if it isn't, if it hasn't got a real basis in music and audio, and in real sort of – in knowing what is good. Improvisation and experimentation can become a mess very quickly. The same with visuals; if the person doing it hasn't got an eye for visuals, colour, composition et cetera, et cetera, et cetera. If they haven't got that experimentation in playing and improvisation generally becomes a right mess. Whereas if it's someone who has got a real grounding in knowing what looks good and knowing what to add when in an improvised way. So right if I do that now that's going to really bring out that kind of mentality. I think that's – for me that's what makes improvisation experimentation really interesting. And I think it is important but depends on the – yeah who's doing it really.

Q: That's really interesting. I hadn't thought of it being like the VJs, like the taste kind of thing, like your – yeah.

A: It's – yeah.

Q: How do you think? I guess, do you think, so if you have these kind of skills, these kind of feel for visuals, do you think this current technology kind of supports that? Like do you think it lets you…?

A: I think there's enough out there that you could do, you know with, I was saying before like open frameworks and processing or creating your own way of processing those areas for artists who want to create a visual thing to create whatever they want with code. So the tools are there you know. I'm not sure how easy it is for everyone to access those or to learn about them. They're not; you know it's not a day's sort of work to become an expert in it. But yeah I think people can, yeah people can find the stuff they need to do it.

Q: Things like modulate allow…

A: Modulate allows a fair amount. It's still a clip base programme though. It's still a playback of pre-rendered stuff. You can do a lot of stuff with it but it's not a real… But then again you are constantly improvising or experimenting. You can buy the mixing of the clips that you do and the effects that you drop on. But I don't think – it doesn't give you the full freedom that you want, that you might necessarily need to do that though. So…

Q: How do you mean? So do you think…?

A: So you're limited by your pre-rendered clips that you've got in there. You know you can colourise them, you can slow them down, speed them up. You can scale them, you can warp them et cetera, but it's still that same clip. It's not like painting from scratch. It's not like – you know you can't do everything you want.

And in terms of sort of 3D; 3D generate – generative 3D it doesn't do anything like that, so I like the fact of having multi elements in a 3D sort of environment which can be all controlled individually. You know it's a quite abstract shape but you can adjust the parameters of each one all in real-time. You know you build the model, you build elements of model, bring them together, coding to manipulate them.

That to me is a lot more sort of improvisational because you can – you know you can create and generate 3D shape on the fly and then you can adjust it in any way. So it becomes more – more experimental and improvisational.

Q: Is that because it's more hands – I guess hands on. Like you actually feel like you're actually manipulating it?

A: Well you're manipulating it – yeah you're manipulating the actual thing itself. You know you're generating it there. You're manipulating it. It's not like it's pre-rendered and you're set with that pre-rendered content that you can do certain things with, but you certainly can't control elements within that scene. You can drop two or three things on top of each other and control them. Yeah certain ways you can do that, but it's still quite limiting compared to generating 3D or generating shapes, generating scenes et cetera.

Q: I guess that comes a little bit back to – like it gives you more potential manipulations and possibilities. Or is it more or is it stronger ones or…?

A: Yeah it is more. There's more you can do but it also relies an awful lot more on sort of pre thinking about it and setting up and developing it. But then it would be nice to get to the stage where there's instruments where it's almost like a synth where it's all generative. It's all sort of using simple generative things. But the more complex the more things it can do, you can you know – making a visual synthesiser. You know there are bits and pieces out there like that but yeah.

Q: Visual synthesiser is interesting.

A: Well that's kind of the way I'm trying to think of what I want to do is making an audiovisual synthesiser kind of thing. So it's quite simple music, it's not complex sample based music, it's generative stuff. Yeah.

Q: I wonder if – I don't know, that's another idea but not for now. You know I guess, so technology wise, I guess we've spoken about it. So I guess what the quality – what do you think of the qualities of the technology or a VJing toll that lets you experiment.

A: Um.

Q: It's a bit of a vague question isn't it?

A: Yeah I mean technology has to be strong because if you want to experiment you need instant feedback and instant results so it's got to be a real time thing with enough power to do what you're trying to do. You know obviously you've always got ceilings and limitations in what you're trying to do. But you don't want to be – you need that instant response as opposed to trying to render stuff, and computer slowing down, trying to do things. So really clean, clean – you know focus code is obviously going to help a lot. And playback machines which are pretty damn powerful. But you can get – you know you can get incredibly powerful stuff now.

Q: What is it about the instant response? What's important about having the kind of…?

A: Well if you're experimenting you need to – you know if you're a musician you're getting an instant thing. If you're playing guitar solo, every single – you know that's how – that's what it is. It's completely instant. If you were sort of playing something having to wait for it to build up into queue and then playback, you don't have a – you know it's not experimenting. You can't improvise with it really because you're a bit frustrated because you're waiting for results of what you do.

Q: Because you have a feel like…

A: You're not sort of tangibly affecting it, it's remote – it's that thing of remoteness. You're playing something and it's in two or three seconds or a minute later it actually comes through. You can't constantly build on something or you can't… Yeah so it has to be – has to be real time.

Q: Cool yeah, it's really interesting because it is like; yeah you need to feel something. You need to be able to feel something to experiment with it to just try something and if it goes wrong maybe it's not right, or flow into it.

A: Yeah you also need to react in it to audio. And the environment things have to react in time or else it's just lagging. It's just slow you know, if you want to trigger something then it's got to happen then or else it's…

Q: I guess people's perception of audio is much better than visual. So like you say you would notice something tiny going wrong with audio.

A: Oh yeah massively, massively. Any mistake or any sort of cock up in audio is so blatant. It's so – yeah it stops everyone in their tracks. But a visual thing isn't so important. It doesn't – because sound obviously encompasses everything around you. You don't have to concentrate on sound to listen to it and to notice things.

Whereas you've got to be looking at a screen to notice a problem. So yeah in many ways visual is easy to get away with stuff. I don't like that as an excuse. I don't like that, I want it to be perfect and I want it to be spot on, and I want it to be just right. I hate cock ups, I hate mistakes. But yeah, so you've got – if it's an audio visual tool it's got to be solid. It's got to be really solid.

Q: Yeah, so I think that's – I think we'll move onto the next one. This is the final one, this is just something that I want to think about that you mentioned earlier with the magnetic man stuff and the pixel. Is everyone – there's one thing that was really mentioned throughout was kind of limitations you face as a VJ. So hardware, software kind of the video format, like you mentioned with pre-rendered and like 3D disco compatibility between things. I guess cost of things, size of stuff to carry round. Maybe time, like Elliot mentioned he hasn't got – his biggest limitation is the time to explore all his ideas.

But the interesting thing I thought about was obviously as well as giving all these barriers. They also kind of give you; they also kind of add a value. So Elliot mentioned his white cube kind of gave him more possibilities, than if he had every visual or colour in the void. He actually comes up with much more interesting ideas.

A: Yeah and that's the same thing, that cube, that pixel, that's what I meant. You can really – you can really create more from limitations sometimes.

Q: Why do you think that is?

A: Psychological question. Maybe because it focuses you, you know there's a real sense of if you've got parameters, if you've got sort of a real sort of a set thing, you focus completely on that, which means you can really spend all the energy on focusing on ways to do that within limitations. If you can do anything then more often than not you kind of do nothing because you've got too – it's too overwhelming to really explore things. And explore everything to its

fullest; you can't do it because you know everything – it's infinite possibilities. But if you're restrained by certain things and you can really push it, and then that actually leads really nicely into then moving those limitations out a bit.

On the same token if it's limitations that you've got that you don't really want it can be incredibly frustrating. You know when we started hardware, laptops, you know the old, when we've got G4 power group we were amazed at what we could do. But it was still incredibly frustrating even just trying to get clips playing back at the speed they were rendered at. And not jerking all those sort of things. Or software crashing on you, that was just frustration really. That was limitations of frustration. So once you know, Mac went to Intel chips got the power up it just felt – you felt free because you could do so much more of the stuff that you really wanted to do and you couldn't do. Those limitations were spread back so you could really sort of fly with it.

Q: Did you think the – when you were with the G4 and you were having ideas, do you think they were because you couldn't do it or…?

A: That's where it's quite difficult. I think when we were back in those days it was, we knew what we wanted to do, we couldn't do it. It wasn't like we sort of – the way to get round it was rendering stuff at lower quality. You know because that was the sort of world we were in then and the actual – most of playback systems we all did everything in, just meant we had to compromise on lower resolution clips, lower quality which affects what the visuals look like. That was our main sort of thing. It wasn't really that we came – in that respect we came up with ideas to get round it and do it, we just had to compromise.

So that was – you know that's less interesting than the sort of limitation on doing the one – the single cube, the one pixel thing. That's a really – because you're self setting those limitations you're really sort of giving yourself a real – it's giving yourself a brief. It's the same with all design work and all sort of creative work. I find if I've got a brief and I've got a set thing to work with, it's much easier to create stuff than if you've got a blank sheet of paper. You know you'd think for a creative person having a blank sheet of paper would be the ideal, but you don't know where to start, you don't know where to begin. But if you nail it down to what you want to achieve you can really explore that and push that and create something.

Or if you've been given a brief by a client, you know, "This is what I want" you've got to work from those parameters. It can be a bit frustrating because you want to do this; X, Y, Z, but you've got to work within those parameters. So you push it and you try harder to get to where you want, if you see what I mean.

Q: Yeah I really do yeah.

A: Yeah.

Q: Yeah that's kind of what I'm – I guess that's what I'm trying to do here really. You get all these kind of parameters and then use them as a kind of tight space to explore something which is…

A: Yeah. Yeah.

Q: It's interesting when you say you were fighting against like video resolution and processor speed, and now basically it's – that problems kind of – apart from ignoring HD, that problem's kind of…

A: Yeah I mean it's – it can always be better you know. I think audio on laptops is pretty good now. You can do an awful lot of very, very high quality audio work on a laptop. But video is still – we still want to do, we want to do 3D disco at higher resolution. We're doing it at 800, 600 at the minute, but we really want to push up to potentially 4768 onto full HD, but the laptops can't do that.

Q: Onto 4k?

A: Well 4k yeah. (Laughs) Laptops can't really do that now. We're looking to buy a real spec-d out performance machine to start pushing it a bit further just to increase the quality and mix more stuff together. So there's always more – at the minute we're still on a slope that is more can make a difference. Yeah, but yeah it has opened up an awful lot more now than what it used to be.

Q: Now because of that do you think you've come up with things like self-imposing limitations like magnetic man because of that?

A: Quite possibly yeah. I think that's a little bit because – yeah if you set yourself a task and confine things a bit it just focuses the mind; it really does focus it. But the magnetic man is a really successful one and I think that's – I'd like to explore that more. That's kind of what I was mentioning before about if I've just got an interface which is a sound wave, what can I do with that? What could you make from it? What can you develop?

I don't know it might be terrible but it's an interesting experiment and it can be simple and developed on and expanded, once all the possibilities are explored with that simple thing then you can start pushing it. You know that's what magnetic man this year is going to be pushing on from what it was, like the single pixels, single cube, whatever it is.

Pushing it on to have more variables, more dynamic elements, more sort of code based patches running in it to develop, to pull it out. But it's still based on the same sort of visual aesthetic that was developed from that.

Q: Do you think there's a risk of losing kind of – I don't know with magnetic man losing the kind of thing that's about if you do spend too much…?

A: Yeah you're very conscious – I am very conscious of that to be honest, I'm always conscious of losing the essence of what you've created by just going too far. And yeah, you know you do that

a lot in a lot of the work we do. Is always sort of remembering to, well hang on, stop what we're trying to achieve here. Yes there's more technology or more possibilities but is that the right way to go? Is that what we want to do? So we do sort of try and force ourselves to think about that a lot as well.

Q: Cool, I think that's really interesting that last one, I think that could come up. I just – maybe I'll – I think I'd just like to just talk about this, the kind of direction I was thinking of going, the first kind of prototype. Because I think what I'll do now is, I want to build a technology in some form and start prototyping things. And then we could look at them and think about how to change them and discuss. So the actual technology is kind of inspiring the discussion and we work together to kind of steer it in the right direction.

A: Yeah cool.

Q: But I think the first, a really interesting – I was just inspired by things you said at the last session and things you said today as well. It's just I was thinking, I don't know how this would work visually, ignore this, ignore what I'm drawing here. I don't know why I'm drawing it, but imagine you've got some either audio or visual thing and I was quite inspired by open frameworks; just being able to get all the pixels as an array. You take some form of – some of – you process the source in some way. Say for example a sign wave, or it could be anything like a colour histogram or a frequency of red pixels, anything. And my initial idea was that you can interact with that to set kind of some form of events that happen when something happens.

So when the sign wave dips below or something. But now I'm thinking maybe you could actually – like you said you could actually manipulate this one quality of the video. So you draw out a quality or some visualisation or something about this – about this source, like a sign wave. And manipulate that directly. And I think, I don't know if that's the kind of – that's the kind of concept I've been interested in basing this on.

A: Yeah, my only slight reservation is when you talk about taking a quick time and splitting it apart, or taking information from the quick time and creating an array from it. Because I kind of, to be honest my real – for me personally I really want to move away from having quick time renders.

Q: Oh yeah.

A: It's sort of like instead of it being a rendered thing I'd want to – it's taken data and taking certain qualities.

Q: Oh yeah I don't mean showing it I mean just…

A: Yeah, no but actually not – you know we don't use sort of quick time, sort of moving away from video. It's a data representation of you know sort of, of something. A sign wave can be a visual thing and audio thing. You know you can change the key of it, you can start then – quite nicely

you've got this line coming, you can pull it up and drop another one on scale, knock it out the phase. But then you can start doing interesting stuff visually with it start having reactive – ah god it's quite hard because I'm not exactly sure what I'm thinking of myself. I mean that's…

Q: So it wouldn't be a video it would be – you create the actual visuals?

A: Yeah. Yeah I really like the sort of the aesthetic of simple things but it's making it interesting enough to become an audio-visual performance. I can send some sort of music to you which I kind of want to go down the – is the audio. It's kind of the…

Q: Audio equivalent of…

A: It's kind of audio that I like and I'm interested in creating in some of the stuff. I'm quite inspired by it.

Q: So would you be interested in something which maybe drew, like did something, that drew in qualities of the audio and let you – let them feed into the visuals? Or is that a bit too sound reactive for you?

A: It's a little bit – it's even going back a bit further in that what you create audio creates a visual. Or what you create visually creates the audio. You're created in it, you're not playing back rendered stuff, you're not playing back samples. You're – so this sort of stuff as well and this is what was at Transmediale

Q: Yeah.

A: I showed you that sort of thing. You know I can see that sort of – you can see a visual sort of theme, so that's almost like broken down like each element.

Q: Yeah.

A: So there's eight streams of audio, you've got a base sort of thing. You've got something sort of similar to the wave and things. You can see the wave form of each thing. Sort of expanding to increase the volume or taking out and adjusting, that is a visual thing as well. Or you zoom into one instrument part of it, and it's like what you do on the screen affects real sort of – it could be fluid dynamics of a visual thing.

Q: Yeah.

A: I guess there's a kind of way talking about kind of limitations as well, we need to actually go to set the – I think set some limitations, set some actual real specifics.

Q: Yeah.

A: So if I – oh it's not going to work is it? What's it called?

Q: It's a way of – because you don't – I think it would – like I think I'd imagine you're not thinking of something like the normal Tenori-on kind of beep when it hits this line kind of thing. Are you

thinking more…? I don't know if that would really give you the manipulation because you're just planning something that's going to happen at that point. Whereas you want to actually be manipulating the sample, getting your hands on the sample.

A: It's kind of trying to get – it's a total experiment; I don't know if it would work. I don't know if it's – you know my audio production isn't great at all. So it's not my strong point, so I'm not sure if that is exactly what – sorry I'm just trying to think of where I can show you some of the sort of stuff which I think.

Q: Yeah how do you do it? I'm just thinking. (Laughs)

A: If I search for…

Q: I just think something like, if you had your sample, how would you do it? And you could change quality to the sample through actually touching and grabbing, and then somehow for a change that sample is in the visual, like a little a little Tenori-on at the end.

A: Yeah.

Q: But you actually – where that – I don't know, it's difficult. (Laughs)

A: It's – I know, I'm just trying to think of – okay so a fluid particle is quite a nice, this is all open framework stuff but… No this isn't. Okay so I don't know what this – what this actually could do or – but there's a fluid, a multi touch sort of thing. It's just simple fluids, it's nothing special but I'd love to think that that; an aesthetic built around that sort of thing could be an audio interface as well as sort of a visual sort of pretty pictures et cetera. I think there could be parameters built around audio as sort of sampler.

It's almost like you've got different spaces that you flick between on the screen possibly as well. There's another thing that you've got – you know you've got your almost traditional sampler. Sort of a sequencer showing the changes and you've got sort of some sort of semblance of control that you can adjust things. And then you can flip to another screen or something that is a focus of one of those that is almost like a shape that parameters could be…

Q: That would be really…

A: You know if you pull a shape down and put more sort of fluid sort of things in, it could be, you know almost like your hertz so your low tones and your high ends and your mid-range is sort of what is happening in each section possibly.

Q: So that's kind of like a bit like this because you go into the quality. You say, "I want to change." You've got these samples and you lay them out in some way that maybe you've done pre to the performance. And you've got kind of a traditional sample, and you go in and you choose what you affect. Or maybe you can affect everything at once. And you do it in kind of a multi touch way that is actually getting your hands on the sample.

A: Well the other, actually the other way of thinking about it is with the – where you've got the reactor vision which is a reacTable basically. So the reacTable is kind of something which is really interesting in that…

Well it's kind of like this sort of thing and I'm not thinking of it just as a VJing thing, but say you've got – can I lend your pencil for a second? You know you've got like your reacTable, you've got certain things that you've got parameters on each one that could be – you know it could be a visual thing.

So it could have like a screen that you end up taking a screen and you've got lots of these things sort of happening and their relationship to each other is what's creating an audio-visual thing. Now it's almost like making those things really aesthetically nice so it becomes like a – it becomes a visual element of it as well. You know that could be really good. So you're pulling on, you've almost got little banks of stuff. Like pre-made or little bits of code. Imagine little bits of code they've got an audio element to them.

So that's known as reverb, but it's a code that's got an animation to it that you drag on and manipulate sort of its range so it takes in more. Sort of sends a pulse out or something. It's doing something, it's – then you can manipulate the visual element in it, you know it can affect the background as well when you're doing it. So it could be fluid sort of things in the background. It becomes like part of the show. You know what I mean? It's really hard to verbalise because I don't really know exactly.

Q: What may be interesting is, maybe is there is a composition with things affecting each other. But the visual is the bit you're zoomed in on, so I don't know you go in on a certain area.

A: Yeah, the only issue, the only problem with doing that is that you might need to – if you're doing an AV show you might need to affect many things at once.

Q: Yeah.

A: And if you do concentrate – but I love that thing that was using touch designer. Oh god I've spelt it wrong. Which I've showed you. So I've showed you this before. That is the audio I've just been playing but I'm sure there's more. There's possibility of instead of them having like mixers and doing all the audio from that sort of – that's the zoomed in part of… That's just obviously audio reactive sort of… So that's the whole – so it zooms in, zooms out sorry from that element. So that's that element on the whole screen and zooms back in to another element. It's lovely; I was blown away by it to be honest. But it's just, the issue with that is it's just a reactive thing.

It's lots of codes just reacting to the audio, and I think you can take it further and have, being a creative thing that creates the audio as well. Do you see what I mean?

Q: Yeah.

A: I don't know exactly how to do it but… (Laughs) Right I'll stop that, but I think the reacTable is definitely something to be inspired by. In terms of having little chunks of things that you drop into an environment that affect other things. And you link them together and then you've got control. I mean have you ever actually seen one? Have you ever played with it?

Q: Not in person.

A: It is good, it's really quite addictive and fun, and I think you can do something similar that's, I don't know, aesthetic. But imagine there's little bits of code, a little patch that does this audio and it plays, you know, and you can drop it onto and then sort of fire it up to come into… You know it's got a volume control or something and you can shrink it or pull it out to set its volume.

Q: That's what I was just thinking with this is you could change which bit of this affected this.

A: Yeah. It would be nice to have two screens. (Laughs) Have one next to each other; one's a detail one, one's a composition.

Q: Cool. I'll have to have a think. (Laughs)

APPENDIX C

Coding Procedures

Throughout this thesis, qualitative analysis was used to interpret the results of both semi-structured interviews and focus groups. These analyses were found to provide an invaluable mechanism to develop understandings of performers' and audiences' practices and experiences. In this appendix, detailed descriptions of the coding procedures followed during these analyses are given, with the aim of guiding those who might wish to employ similar approaches in their own interaction design practices.

Thematic Analysis

A thematic analysis was conducted as part of the study of VJ practice presented in Chapter 4. This analysis followed guidelines set out by Braun and Clarke (2006) using the qualitative analysis software NVivo[1]. The first stage involved transcribing the data from the focus groups and interviews. Following transcription, the data was open coded to highlight potential trends in the participants' discussion of their practices. This process involved a number of *passes* through the data. On the initial pass, excerpts that were in any way interesting or remarkable were annotated with short descriptions of a few words at most. In subsequent passes, the data was re-examined for the presence of passages that related to these emerging codes. As this iterative process went on, codes were often re-named to reflect my developing interpretation of the excerpts to which each referred. Figure 41 shows the interface that was used to do this coding in NVivo. The coloured bars to the far right of the interface illustrate the codes that were applied to the passages shown.

[1] While the analysis was completed using NVivo 8, the illustrations in this appendix show the newer version 10 of the software. However, the functionality, interface structure and workflow are almost identical to those used during the analysis process.

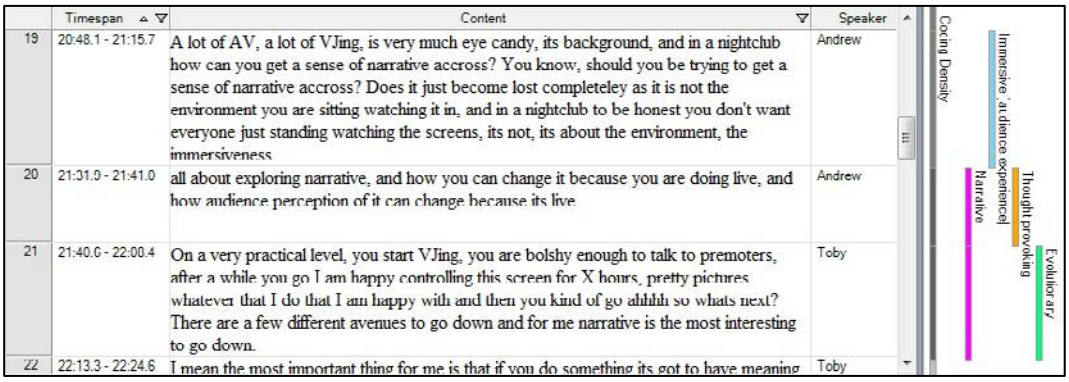

Figure 41: Coding transcribed data directly in NVivo

In the next stage of the analysis process, these initial codes were iteratively grouped into a tree structure. In some cases, this structure was formed by making particular codes *children* of others while in other cases new codes were introduced to represent a particular grouping. Figure 42 shows the coding structure that would become the superordinate theme Aspirational.

Name	Sources	References
Aspirational	0	0
Communication of meaning	2	4
Narrative	3	7
Recontextualisation	3	3
Evocative	0	0
Astonishing	1	1
Emotional	1	1
Immersive (audience experience)	2	4
Live (audience experience)	4	8
Thought provoking	1	3
Evolutionary	4	7
Technology driven	2	4
Pride	2	5
Slickness	2	5

Figure 42: The final coding structure for the superordinate theme "Aspirational"

The final step of the thematic analysis process involved producing a written account of the themes, which formed the basis of the thematic articulation presented in Chapter 4. It was found that writing this account acted as a reflective process through which the nature of the themes could be understood, interpreted and further developed.

Interpretive Phenomenological Analysis

The qualitative analyses conducted throughout the remainder of the thesis used the IPA (interpretive phenomenological analysis) method, following a process described by Smith (2007). The IPA procedure adopted shared many similarities with the thematic analysis described in the previous section. However, these analyses are referred to as IPA to stress the focus on individuals' perspectives and experiences adopted throughout the process.

Each analysis commenced by coding data, which had been transcribed by a professional company. A multi-pass coding process was followed, during which the transcripts were first open coded to highlight excerpts that offered insight into the individual relationships between the subjects' practices and key issues of live performance. Furthermore, additional passages were coded that proved to be interesting, surprising or in any other way significant. Due to a number of technical problems experienced during the previous thematic analysis process, it was decided to conduct this process without specialist qualitative analysis software. Instead, the process was completed by simply writing codes in the left-hand margin of printed copies of the transcripts. Figure 43 illustrates such an annotated transcript.

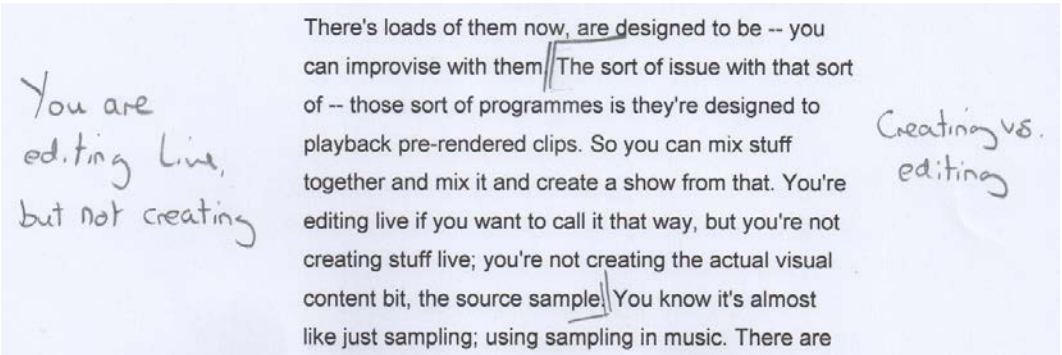

Figure 43: An annotated transcript from one of the IPA processes conducted

Following the initial coding of transcripts, a process of grouping codes together into themes took place. This process involved a further coding pass, during which possible themes were marked in the right-hand margin. Once this process had been completed a digital record of the codes and emergent themes was created by copying the themes, codes and associated passages into a Microsoft Word document (Figure 44).

Creating vs. editing

Page	Comment	Quote
1.33	You are editing live, but not creating	The sort of issue with that sort of -- those sorts of programmes is they're designed to playback pre-rendered clips. So you can mix stuff together and mix it and create a show from that. You're editing live if you want to call it that way, but you're not creating stuff live; you're not creating the actual visual content bit, the source sample.
1.33	Interested in creating visuals from scratch	All those sort of more code based, node based, things you can then have generative graphics. And that's something that does interest me quite a bit as well, is actually generating stuff from scratch.
1.34	Modul8 is great, but it doesn't do generative visuals	Now we use modulate an awful lot for more just video playback and visuals VJing. It's fantastic; it's a great programme; dead stable all those sort of things which you need for live performance. But it doesn't do the generative stuff very well.
1.34	He likes the idea of creating something from scratch	I don't like it particularly but I like the essence of what it's about, or creating something from scratch myself not as a VJ programmer but as a visualizer or visual creative generative thing in the likes of open frameworks processing.
2.5	Flow associated with live creation	Whereas if I did a pure laptop set, which is a bit different because you know that all your levels are right. Everything's

Figure 44: A section of one of the digital records of the coded data

The final stage of the IPA process involved creating a written description of the themes that had emerged. As with the previous thematic analysis process, this report-writing phase was found to inspire further reflection on and subsequent development of the emerging themes. For instance, the notion of Generative Manipulation, which guided the design of Waves, was developed during this report-writing phase by examining passages grouped under the initial theme Creating vs. editing. The report-writing phase of the IPA procedure was found to play a particularly important role in analysing the results of the evaluation of Waves. In this case, two sets of themes had been developed separately; one based upon the performer's comments and another on those of the audience. The report-writing phase allowed me to compare and contrast the different perspectives represented in these analyses, to develop the combined set of themes that is presented in Section 5.7.

APPENDIX D

The Waves Design

In this appendix a detailed description of the Waves design is given. It is intended that this description will augment that given in Section 5.6 and, therefore, further inform interaction designers and researchers, who might gain inspiration or guidance from the design and the forms of interaction that it comprises.

Menu

Wave Objects are created using a pop-up menu. The menu is opened by pressing and holding a single finger in any region of the interface that is not occupied by a Wave Object or the Wave Cylinder. A *press and hold* widget provides the user with feedback about how long they must hold down their finger for (Figure 45).

Figure 45: The press and hold widget

The menu is comprised of three tabs. The first of these tabs "New" shows a grid of icons, which each show the name and a preview image of a visual (Figure 46). If the user touches one of these icons, a new Wave Object is created using that visual. The "Load" tab functions in a similar manner. However, a grid of icons representing saved Wave Objects are shown. When one of these icons is clicked, a Wave Object is created that matches that saved configuration.

Figure 46: The menu showing the "New" tab

The final "BPM" tab allows the user to set the rate at which visuals are *played back* by the system, in beats-per-minute. The user is able to set this rate manually, by pressing and holding either the plus or minus buttons until the desired value is displayed. Alternatively, the large "Tap" button can be pressed in time with the beat of a track, in order to adopt its BPM. If the tap functionality is used, the value can then be adjusted using the plus and minus buttons.

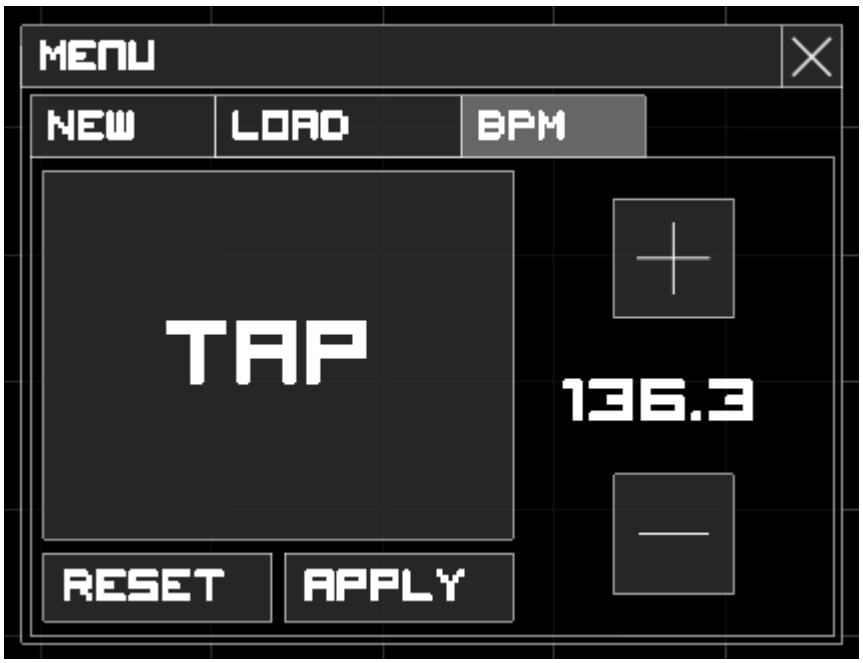

Figure 47: The "BPM" tab of the menu

Wave Objects

A Wave Object represents an instance of a visual in the interface. Each Wave Object has a set of common controls (Figure 48). In the top right of the Wave Object a *preview screen* shows a thumbnail image of what the visual will look like when rendered with the current parameter values. A button with a projector icon, cue, allows the user to select whether the visual will be shown on the large screen or not, when attached to the Wave Cylinder. A button with a right-angled arrow icon allows the user to reset all of the parameter values of the Wave Object to their default values. A button with a downward facing arrow icon allows the user to save the current configuration of the Wave Object, so that it can be loaded from the menu at a later time. Finally, a button with a plus icon at the bottom left of the Wave Object brings up a menu that displays a list of the parameters of the visual associated with the Wave Object. The user can press on one of the items in the list to add a track that controls that parameter. Wave Objects can be moved around the interface by pressing and dragging a finger within the bar to the left, which also displays the name of the visual.

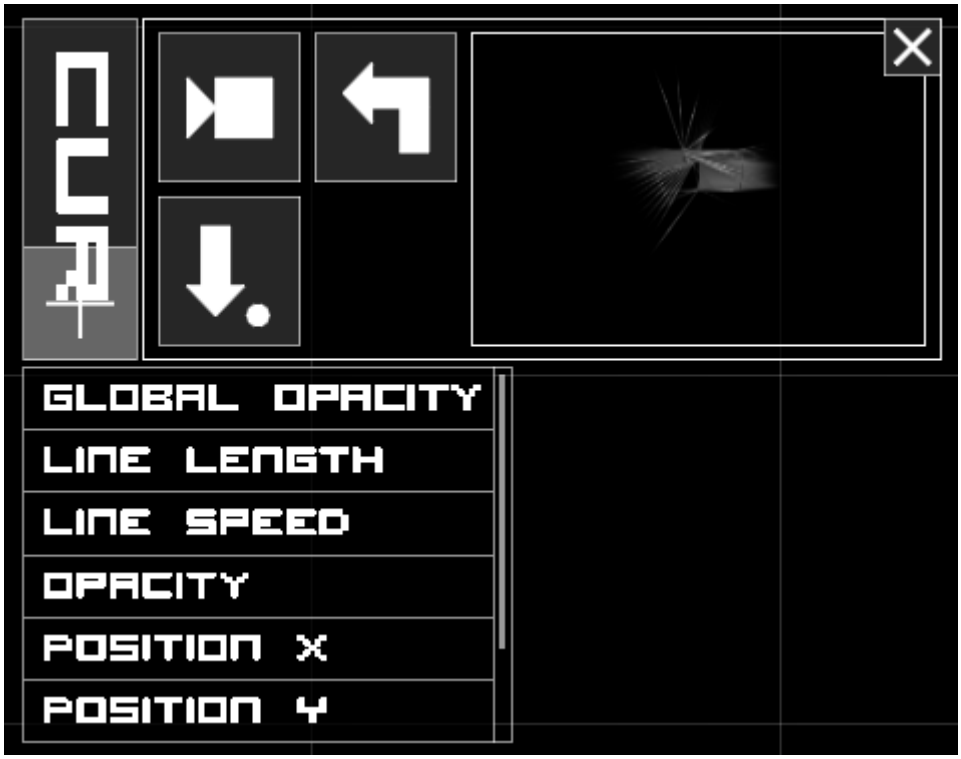

Figure 48: The common controls of a Wave Object

In addition to a set of common controls, a Wave Object also has a number of tracks. Each track allows the user to set the values of a parameter of the visual associated with the Wave Object. There are two kinds of tracks within the Waves interface: standard tracks, which allow the user to set a series of parameter values over time, and audio-reactive tracks, which allow the user to specify a range of frequencies from an incoming audio signal that the parameter will respond to. An icon at the top left of each track can be pressed to switch between these modes.

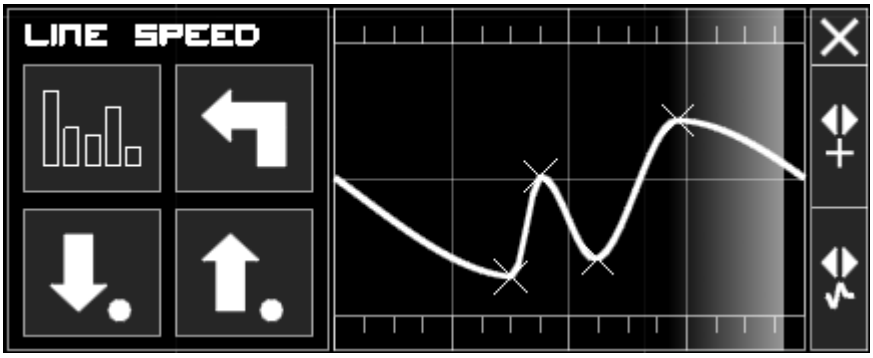

Figure 49: A standard track, which represents the parameter "Line Speed"

A standard track (Figure 49) represents a series of parameter values over time using a spline curve. The shape of this curve can be manipulated by adding control points. To add a control point, the user presses and holds his or her finger on a position on the curve. Once a control point has been added, the user can move its position by placing his or her finger on it and dragging it to a new position. To remove a control point, the user can drag it outside of the bounds of the track and release their finger. Each standard track has a play head, a gradient widget that was designed to resemble the cursor of a radar screen. The value of the parameter associated with the track is determined by the value at the intersection between this play head and the spline curve. A standard track can be of variable length. The user can extend or shorten a track by dragging one of two different icons to the right of the track. If the top icon is used to increase the length of a track, then more space is added where additional control points can be created. If the bottom button is used to increase the length of the track, then the current pattern of control points on the track is replicated in the space created. When increasing or decreasing the length of a standard track, the track snaps to a length of 1, 2, 4, 8, 16, 32 or 64 beats. This ensures that the parameter values represented by the track can be rendered onto the Wave Cylinder, which represents 64 beats.

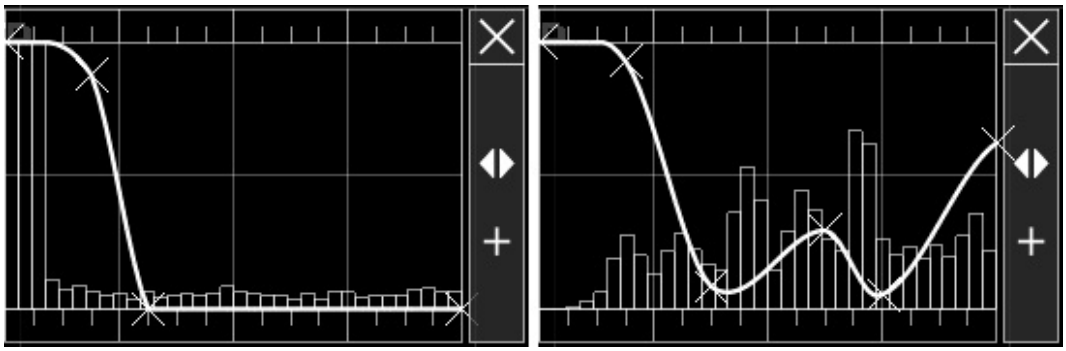

Figure 50: Audio-reactive tracks, configured to react to different frequencies

The second type of track, audio-reactive, uses the same spline-based interaction to control a range of frequencies that determine the value of the parameter associated with the visual. The user can add, adjust and remove control points to the spline curve in a similar manner to the standard track. The length of the track can be adjusted using the button to the right of the track. As the length of an audio-reactive track does not relate to time, like it does in a standard track, adjusting its length simply gives the user a larger space to make more detailed configurations of control points. A histogram is rendered onto the background of each audio-reactive track, which shows the distribution of frequencies from an audio track, which is captured from the line input of the computer running the system. Bass frequencies are shown toward the left of the track, while treble frequencies are shown to the right. To compute the current parameter value from the track, the value of each frequency bin within the frequency distribution is scaled by the value at the intersection between its position on the track and the spline curve. The sum of these scaled frequency bin values is computed and then divided by the number of bins to give the parameter value. Computing the value in this way allows the user to specify that the parameter should respond to particular parts of the audio track, by simply moulding the shape of the spline curve to be *higher* at positions of desired frequencies.

The user is able to save a pattern of control points by pressing a button to the left of a track, which has a down arrow icon. Additionally, previously saved sequences of parameter values, and a number of pre-set patterns, can be loaded by pressing the adjacent button, which has an up arrow icon. When this load button is pressed, the track is overlaid with a linear menu showing the currently saved patterns (Figure 51). If the user clicks on one of the patterns in this menu, the

current control points on the track are removed and replaced with those of the saved pattern.

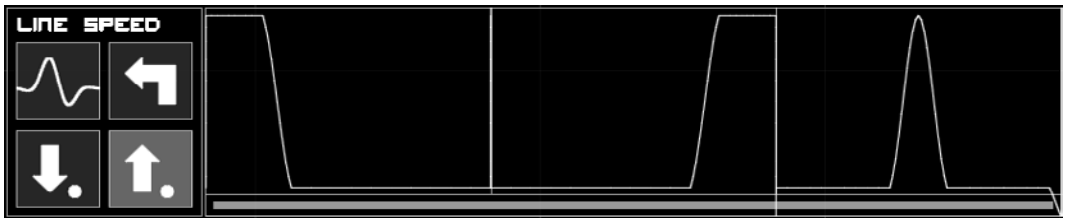

Figure 51: A menu showing previously saved patterns of control points

Wave Cylinder

The Wave Cylinder (Figure 52) acts as a *player* for Wave Objects. The Wave Cylinder is a large rotating cylinder to the left of the interface. The cylinder rotates at a speed governed by the current BPM. One full rotation of the cylinder represents the passage of 64 beats. A textual display at the top centre of the cylinder shows its current position in this loop. Dragging, or *scratching*, a finger within the cylinder adjusts the position. This allows the user to synchronize the playback of Wave Objects with an audio track.

When a Wave Object is attached to the cylinder, its visual is rendered on the background of the interface and, if the cue button is selected on that object, rendered as part of the projected output of the performance. Wave Objects can be dragged up and down the cylinder. The ordering of objects on the cylinder determines the rendering order of Visuals, where the object at the bottom is rendered first and the object at the top last, using the painter's algorithm.

When a Wave Object is dragged into close proximity of the Wave Cylinder, that object attaches to its side. Once an object is attached to the side of the cylinder, its name and parameter values are rendered onto the surface of the cylinder. In the case of an object's standard tracks, the pattern of control points is shown on the surface of the cylinder. The parameter value for each standard track is then computed as the intersection between the rendered pattern of control points and the play head, a horizontal line drawn down the centre of the cylinder. In the case of an audio-reactive track, a straight line showing the current parameter value, computed from the incoming audio signal, is rendered.

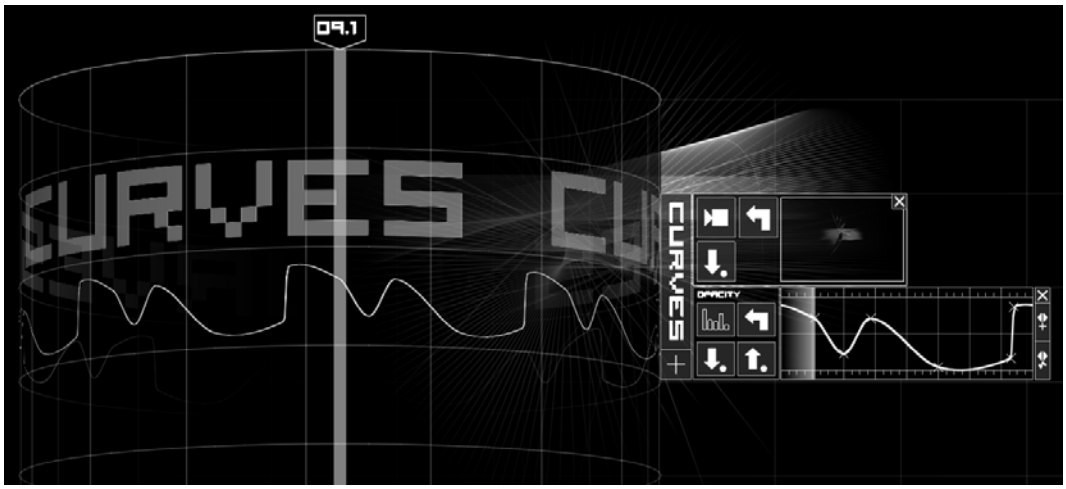

Figure 52: The Wave Cylinder with a single Wave Object attached

Visuals

The visuals of a Waves performance are programmed in C++ using either OpenGL 1.5 or the OpenFrameworks OpenGL utility functions. To support the creation of visuals that can be easily integrated into the system, an abstract Visual class was created that all visuals inherit from. This class contains a range of helper functions that can be used to specify a visual's parameters and determine their values, as set in the Waves interface. Additionally, the class has two pure virtual functions: draw and update. By writing functions that inherit these pure virtual functions, the VJ can specify code that is called by the system to render and update the behaviour of a visual, without the need to interact with the larger Waves code base.

Implementation

The Waves system was implemented with C++ and the graphics libraries OpenGL 1.5. The Waves system has been made publically available under the GNU General Public License. For further details of the Waves implementation please browse the code-base at https://github.com/jonathanhook/waves.

APPENDIX E

The Physics Synth Design

In this appendix, a detailed description of the Physics Synth design is given. This description offers further information about the design for those who might wish to utilise it in their practices or draw inspiration and guidance from it when designing future interfaces.

Menu

A menu, on the left-hand side of the interface, is central in much of the user's interactions with Physics Synth (Figure 53). This menu allows the user to create, erase and manipulate the parameters of the Worlds and Objects within the physics simulation; configure the control messages sent out by Physics Synth and alter a number of other settings. The user is able to switch between these modes using a set of radio buttons on the top of the menu. Depending on the mode selected, a different set of controls is displayed in the bottom portion of the menu.

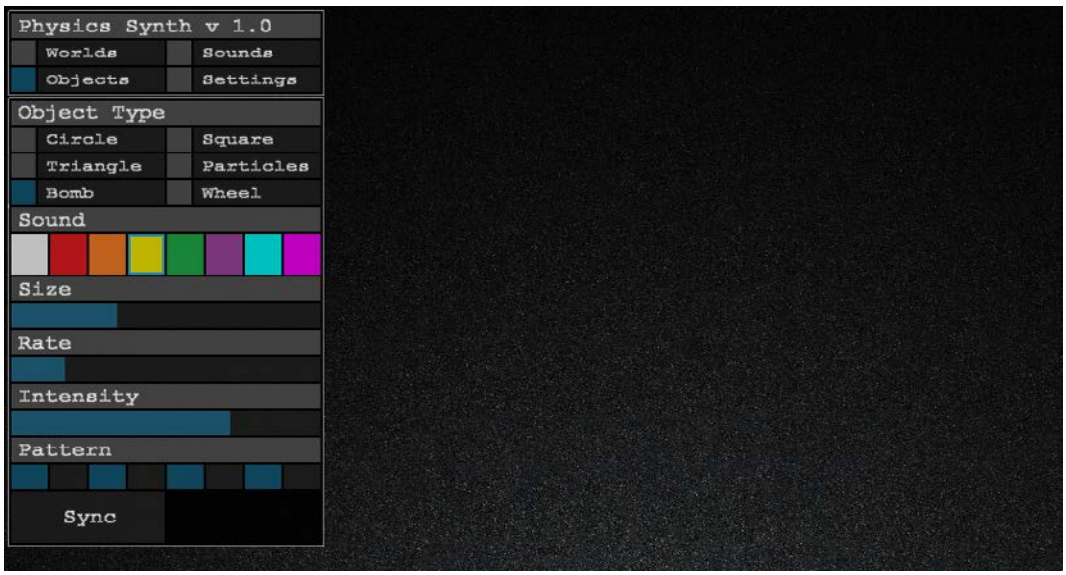

Figure 53: The Physics Synth interface, showing the menu (left)

Worlds

A World represents a distinct physics simulation, which comprises a number of Objects. The behaviour of, and interactions between, these objects are governed by that World's physics simulation. Worlds can be either circular or square shaped (Figure 54).

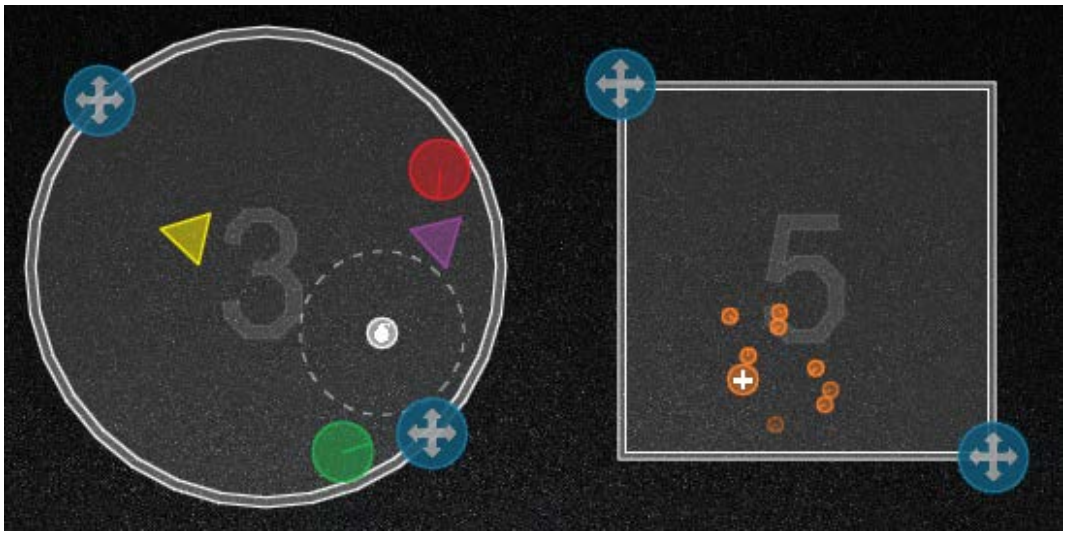

Figure 54: Circular (left) and square (right) Worlds

To create a World, the user must put the menu into World mode by selecting the appropriate radio button. Once the menu is in World mode, the user is able to select the type, size and gravity vector of the World (i.e. the direction and strength of gravity within the simulation) that is to be created by using the controls in the bottom portion of the menu (Figure 55).

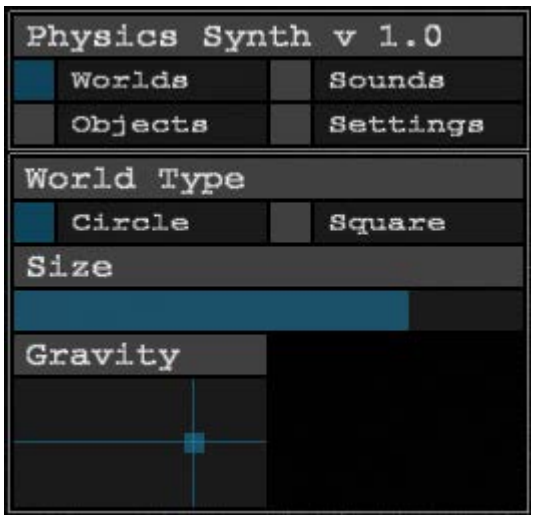

Figure 55: Using the menu to configure a World prior to creation

Once the initial parameters of the World have been set using the menu, the World can be created by pressing and holding a single finger in any area of the interface that is not occupied by the menu or another World. A press and hold widget (Figure 56) presents the user with feedback about how long they must hold down their finger for to confirm the creation of the World. If this press and hold gesture is completed, the World is added to the interface beneath the position of the user's finger.

Figure 56: The press and hold widget

The user can move a World around the interface by pressing and dragging their finger within one of two blue circular regions on its boundary (Figure 54). The user can also select the World by tapping on one of these regions. Once a World has been selected, the menu automatically assumes World mode. The user is then able to alter the parameters of that World using the menu. A blue border around the edge of the menu indicates that it is being used to manipulate the parameters of an existing World, rather than configure those of one that is to be created. An erase button allows the user to delete the selected World and all of the objects it contains. The menu also displays a list of the Objects within the World (Figure 57). The user can touch an item in this list to select an individual Object.

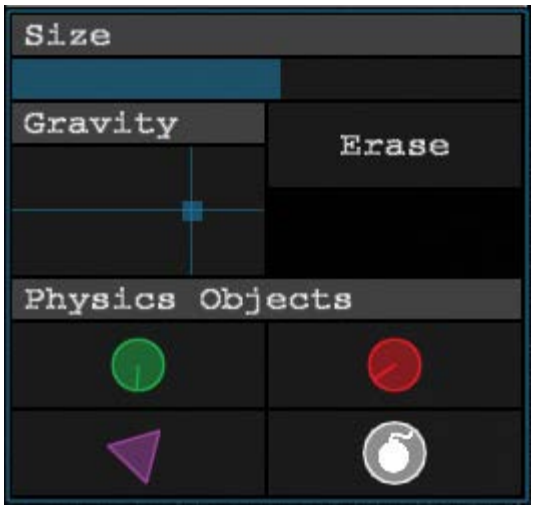

Figure 57: Using the menu to configure an existing World

Simple Objects

Physics Synth allows the user to create two types of Physics Objects. The first of these are Simple Objects. Simple Objects represent basic polygonal forms within the physics simulation. There are three types of Simple Object in the current version of Physics Synth: circles, squares and triangles (Figure 58). Each Simple Object has three parameters that can be configured by the user to alter how it behaves within the physics simulation: size, bounciness and friction. Each Simple Object can be given a colour, which determines the kind of control messages that it produces. Additionally, Simple Objects can be set as *Locked* so that their position remains static within the simulation. This allows the user to create buffers and barriers for other Objects to collide with.

Figure 58: Simple Objects

Simple Objects are created in a similar manner to Worlds. To create a Simple Object, the user places the menu into Object mode. The user may then use the bottom region of the menu to set the type, colour, friction, bounciness and size of the object that they are going to create (Figure 59). Once these options have been set, the object is created by pressing and holding a finger within a World, at a position that is not already occupied by an Object. If this press and hold gesture is completed, the Simple Object is added to the World at the position beneath the user's finger.

The user can select a Simple Object using the list within a World's menu, or by touching it with their finger. Once the user has selected an object, it is given a blue border and the menu assumes Object mode (Figure 59). The user can then use this menu to configure the parameters of the selected Object or to delete it. The user is currently unable to change the type of a selected Simple Object.

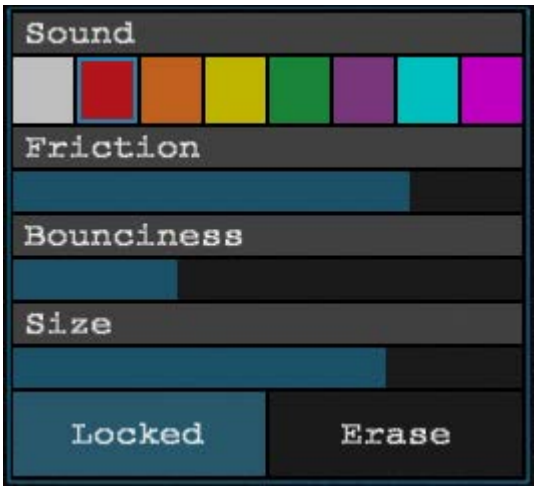

Figure 59: Using the menu to configure an existing Simple Object

Once a Simple Object is within a World, the user can manipulate its position by touching it and dragging their finger. When a user touches a Simple Object, a springy joint is connected between the centre of the user's finger and their initial point of contact on the object (Figure 60). Consequently, as the user moves their finger the object is pulled to its new position. By using a spring instead of a rigid joint, interaction is afforded that mimics an elastic band being connected between the user's finger and the object. As a result, objects can be easily flicked and swung around the interface.

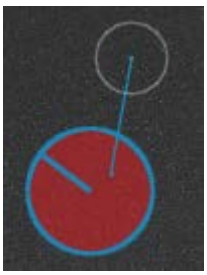

Figure 60: Interacting with a Simple Object using a *springy* joint

Dynamic Objects

Dynamic Objects are the second type of Physics Object. Dynamic Objects differ from Simple Objects as they introduce repeated automatic behaviour into the physics simulation. Dynamic Objects are represented on the interface with a small circular icon, which can be touched upon to select or dragged to move. Dynamic Objects can be created, erased and manipulated using the menu, in a manner similar to a Simple Object. There are three types of Dynamic Object: Particle

Emitters, Wheels and Bombs (see Section 6.4.3 for a description of the different Dynamic Objects).

To allow the user to control their automated behaviour, each Dynamic Object has two special parameters: rate and pattern. The rate parameter, which can be set with a slider, controls the rate at which the Dynamic Object's automated behaviour is executed. In the case of the Particle Emitter, the rate parameter controls the frequency with which particles are created; for the Wheel, the rate parameter controls the rotation speed of the spokes and, in the case of the Bomb, the rate controls the frequency of *explosions*. The pattern parameter represents an eight-element pattern in a Dynamic Object's behaviour. The pattern parameter is set using a special widget, which comprises eight toggle buttons. Each of these buttons can be selected or de-selected in order to specify whether an element in the pattern is active or not (Figure 61). In the case of the Particle Emitter, this parameter can be used to create a pattern in the production of particles, while in the case of the Bomb a pattern can be created in a series of explosions. In the case of the Wheel, the pattern parameter is used to set the number and sequence of spokes that rotate around the centre-point of the object.

Figure 61: A pattern widget with every other element activated

The automated behaviour of Dynamic Objects is tied to a global clock signal. As a result, the Particle Emitters creation and propulsion of particles, the Wheel's rotation and the Bomb's explosions can all be synchronized with a beat. As the user is able to freely alter the rate parameter, the automated behaviour of Dynamic Objects can drift from this clock signal. A synchronize button allows the user to bring the behaviour of a Dynamic Object back into line with the clock signal if such drifting has occurred. This synchronize button also *snaps* the rate parameter to a value that will prevent further drift.

Sound Control Messages

The Physics Synth transmits OSC (open sound control) messages, which can be used to control a range of music software packages. These messages are produced

by the interface when Simple Objects or the particles produced by the Particle Emitter collide with each other or the boundary of a World. The user can choose to transmit two different types of message: Raw and Impulse. Both types of message contain an ID for the World that the collision occurred in and an ID for the colour of the Object. It was intended that this second ID would allow the user to easily switch between configurations within external music software packages by changing the colour of objects. For instance, a software package might be configured to synthesise a sound at different frequencies depending on the colour of the object involved in a collision.

Raw messages have the address pattern "/psynth/raw" and transmit raw data about the physical properties of a particular collision, in addition to the aforementioned common parameters. The following values are transmitted: position, angle, velocity, spin speed, inertia and the force of impact. Figure 62 shows the protocol specification for Raw messages.

```
-- Raw Data Profile --

Message Format:

/psynth/raw set [Parameters]

Parameters:

[id]    [description]           [type]          [range]
-------------------------------------------------------
w       worldId                 (int32)         0:8
s       sampleId                (int32)         0:7
x, y    position                (float32)       0.0:1.0
a       angle                   (float32)       0.0:1.0
v       velocity                (float32)       0.0:1.0
S       spin                    (float32)       0.0:1.0
i       inertia                 (float32)       0.0:1.0
c       contact impulse         (float32)       0.0:1.0
```

Figure 62: The Raw message protocol

A Max/MSP (Cycling 74, 2012) patch was created that processed these messages and presented the user with each value as an individual outlet. It was intended that this patch would offer the musicians easy access to data in both Max/MSP and Max for Live, without requiring them to process the messages themselves. It is intended that similar client components will be created to integrate the data produced by Physics Synth into many other music software packages in the future.

Impulse messages have the address pattern "/psynth/impulse" and transmit values that can be used to control the Impulse Sampler within Ableton Live (Ableton, 2012). Impulse messages were included in the design in order to allow Paul to manipulate the mappings between the physical properties of collisions and the parameters of the Impulse sampler from within the Physics Synth interface, rather than by interacting with his laptop during performance. Each impulse message contains IDs for the World that a collision occurred in and the colour of the colliding object. The colour of the colliding object is used in Ableton Live to control the sound sample used by the sampler. Additionally, Impulse messages contain a series of values, which map to the transpose, stretch, drive, frequency, resonance, decay and pan parameters of the sampler. Figure 63 shows the protocol specification for Impulse messages.

```
-- Impulse Profile --

/psynth/impulse set [Parmeters]

[id]    [description]           [type]          [range]
-------------------------------------------------------
w       worldId                 (int32)         0:8
s       sampleId                (int32)         0:7
t       transpose               (float32)       0.0:1.0
st      stretch                 (float32)       0.0:1.0
dr      drive                   (float32)       0.0:1.0
f       frequency               (float32)       0.0:1.0
r       resonance               (float32)       0.0:1.0
de      decay                   (float32)       0.0:1.0
p       pan                     (float32)       0.0:1.0
```

Figure 63: The Impulse message protocol

The mapping between collision properties and parameters of the Impulse sampler can be set using a Menu within the Physics Synth interface (Figure 64). This menu allows the user to set these mappings for each object colour within the interface. The user can select a colour by pressing on one of the coloured regions of at the top of the bottom portion of the menu and then use the left and right buttons to define mappings between collision properties and parameters of the sampler. Consequently, the user can assign different parameter mappings between colours and, therefore, easily switch between them during performance by altering the colour of objects. This menu is also used to define whether Raw or Impulse messages are transmitted in response to collisions by objects of a particular colour.

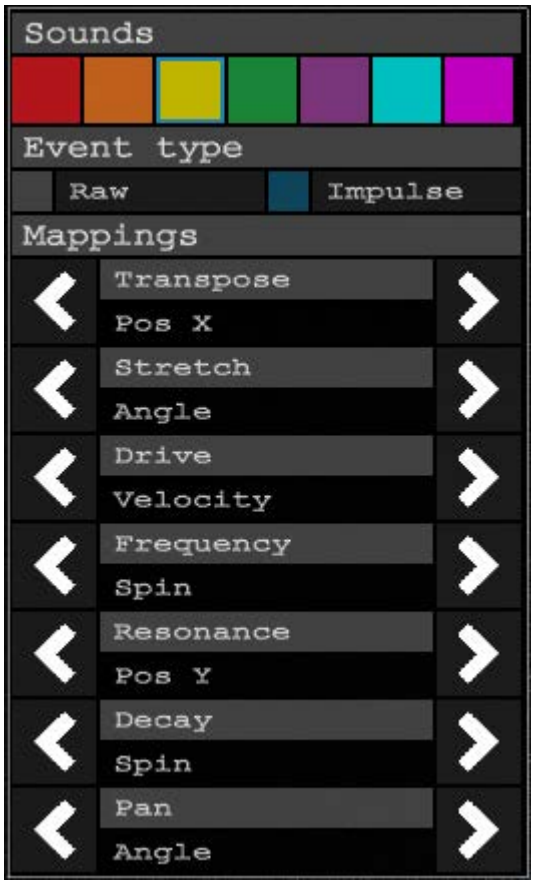

Figure 64: Sound configuration menu

A Max/MSP patch was created that utilised Max For Live (Ableton, 2013) to directly manipulate parameters of Ableton Live's Impulse sampler, in response to incoming control messages. This patch can be easily dragged into a track within the Ableton interface, along with an Impulse sampler object. If multiple copies of the patch are included in multiple tracks, the World ID element of the Impulse message is used to determine which track that the message is used to control. Figure 65 shows the patch being used to control the Impulse sampler in Ableton Live.

Figure 65: Controlling the Impulse sampler using Mac for Live

Implementation

Physics Synth was implemented using C++ and the graphics libraries OpenGL 1.5. Like Waves, Physics Synth has been released under the GNU General Public License. For further details of the Physics Synth implementation please browse the code-base at https://github.com/jonathanhook/physicssynth.

APPENDIX F

Video Material

The following videos are included on the DVD attached to this thesis:

Chapter 3 – Exploring VJ Practice

- Documentary Film
- Creative Response – 3D Disco
- Creative Response – Electro Flamenko
- Creative Response – Kinetxt
- Creative Response – Tron Lennon

Chapter 4 – Designing Waves

- Waves – Promo Video
- Interview Prompt – Audience
- Interview Prompt – Performer

Chapter 5 – Designing Physics Synth

- Physics Synth – Promo Video
- Interview Prompt – Adam
- Interview Prompt – Guy
- Interview Prompt – Paul